CO-USE OF TOBACCO AND CANNABIS: DEVELOPMENT AND EVALUATION OF TAILORED INTERVENTIONS

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ABSTRACT

Tobacco and cannabis use often co-occur and are strongly interrelated, with connecting mechanisms that likely extend beyond those linking co-use of drugs in general. Among the particular mechanisms is the common route of administration. Since both substances are usually smoked, using one can serve as cue for the other. On the one hand, this link may promote the progression to more frequent use of these substances. On the other hand, it may also be problematic in the context of cessation attempts. Evidence suggests that co-users are less successful in quitting tobacco and cannabis, respectively, than smokers of only one substance. However, current national and international interventions typically focus on one substance, and address the other substance either only marginally or not at all. Growing evidence suggests a need for dual-interventions for co-users of both substances.

In line with this, the current thesis aimed at the development and evaluation of interventions tailored to co-smokers of tobacco and cannabis. Three research articles (labelled Paper 1, 2, and 3) constitute the central part of this thesis. Paper 1 presents the first steps of the development process. A preliminary study analysed the demand for and possible designs of an intervention for co-smokers through two focus groups and an online survey with current and former co-smokers as well as through expert interviews. Because these revealed a demand for a combined intervention, we developed an integrative group intervention for simultaneous cessation of tobacco and cannabis use. Paper 1 includes a detailed description of this dual-intervention and ratings of its acceptability. Both the course participants and the course instructors evaluated the program positively and especially appreciated the group discussions and modules for developing personal strategies that could be applied during simultaneous cessation of tobacco and cannabis.

Paper 2 evaluates the cessation course regarding feasibility, safety, and initial effectiveness, using a within-subjects design with pre-, post-, and 6-month follow-up

assessments. Of the 77 participants, 23.4% reported abstinence from cigarettes, cannabis, or both at the follow-up. The separate, self-reported abstinence rates for cigarettes and cannabis were 10.4% and 19.5%, and cotinine-validated dual-abstinence was achieved by 5.2% at the follow-up. Furthermore, the frequencies of tobacco and cannabis use decreased significantly over the study period. The treatment retention amounts to 62.3%. Only three participants discontinued their participation due to severe problems that emerged during the treatment and no hospitalisations as a consequence of course participation were reported.

Because the preliminary study also indicated only a modest readiness for simultaneous cessation, we additionally developed three brief, web-based and fully automated motivational interventions that aimed at enhancing co-smokers' readiness for a simultaneous quit attempt. The first intervention combined self-assessments of cigarette and cannabis use with personalised, normative feedback, the second one was based on principles of motivational interviewing, and the third one merely provided information on tobacco, cannabis, and their co-use. Paper 3 evaluates these interventions, using a randomized trial design with pre-, post- and 8-week follow-up assessment ($N = 325$). For the post-intervention assessment, the analyses revealed a significant increase in the readiness to quit tobacco and cannabis in the total sample, $B = 0.33$, 95% CI [0.10, 0.56], $p = .006$. However, this effect was not significant for the comparison between baseline and follow-up assessment. Furthermore, no differential effects between the interventions were found. In addition, there were no significant differential intervention or time effects on the frequency of tobacco or cannabis use.

The findings indicate that simultaneous treatment of tobacco and cannabis use is feasible, at least within the analysed cessation intervention. However, the evaluation of this intervention and of the web-based interventions suggest that addressing tobacco and cannabis simultaneously is complex and may require more intensive interventions, especially when sustained dual-abstinence is the main goal. Future research should take this complexity into account and evaluate the efficacy of dual-interventions with randomized controlled studies.

ZUSAMMENFASSUNG

Cannabiskonsumierende rauchen meist auch Tabak und der Konsum beider Substanzen ist auf vielschichtige Weise miteinander verwoben, wobei verbindende Mechanismen vermutlich über diejenigen hinausreichen, die Co-Konsum von Substanzen im Generellen erklären. Ein wichtiges Verbindungsglied stellt die Konsumform dar: Von der überwiegenden Mehrheit der Co-Konsumierende werden beide Substanzen geraucht, wodurch der Konsum der einen Substanz als Hinweisreiz für die andere fungieren kann. Daraus kann sich einerseits eine Steigerung der Konsumhäufigkeit ergeben; andererseits bereitet dieser Mechanismus aber auch häufig im Rahmen von Konsumstoppversuchen Schwierigkeiten. So zeigen Studien, dass Co-Konsumierende von Tabak und Cannabis weniger erfolgreich sind beim Ausstieg aus dem Tabak- bzw. Cannabiskonsum als Rauchende von nur einer der beiden Substanzen. Trotz dieser Befundlage sind nationale und internationale Interventionen für den Ausstieg aus dem Tabak- bzw. Cannabiskonsum in der Regel nur auf eine der beiden Substanzen ausgerichtet und behandeln die andere entweder gar nicht oder lediglich am Rande. In der Literatur werden zunehmend Interventionen gefordert, die auf Co-Rauchende zugeschnitten sind.

Dementsprechend war das Ziel dieser Dissertation, Interventionen für Co-Rauchende zu entwickeln. Drei Artikel (Paper 1, 2 und 3) stellen dabei den zentralen Teil dieser Arbeit dar. Paper 1 beinhaltet die ersten Schritte des Entwicklungsprozesses dieser Interventionen. In einer Vorstudie wurde der Bedarf an derartigen Interventionen anhand von Interviews mit Fachpersonen sowie Fokusgruppendiskussionen und einem Online-Fragebogen mit ehemaligen und aktuellen Co-Rauchenden untersucht. Zusätzlich wurden Vorschläge für die Ausgestaltung solcher Interventionen gesammelt. Da ein Bedarf festgestellt wurde, wurde im Anschluss ein integratives Rauchstopp-Programm zum gleichzeitigen Tabak- und Cannabis-Ausstieg im Gruppensetting entwickelt. Paper 1 enthält neben der Vorstudie eine detaillierte Beschreibung dieser Intervention sowie bereits Befunde zu ihrer Akzeptanz durch die

Teilnehmenden und Kursleitenden, welche am Kursende (Teilnehmende) bzw. nachdem alle Kurse abgeschlossen waren (Kursleitende) erhoben wurde. Sowohl die Teilnehmenden als auch die Kursleitenden bewerteten die Intervention sehr positiv, wobei sie insbesondere die Gruppendiskussionen und die Module schätzten, welche zur Entwicklung persönlicher Strategien zur Unterstützung beim gleichzeitigen Tabak- und Cannabis-Rauchstopp konzeptualisiert worden waren.

In Paper 2 wird das Rauchstopp-Programm hinsichtlich Machbarkeit, Sicherheit und ersten Hinweisen auf Effektivität mit einer Prä-, einer Post- sowie einer Follow-up-Erhebung evaluiert. Bei der Follow-up-Messung berichteten 23.4% der 77 Teilnehmenden Abstinenz von Zigaretten, Cannabis oder beiden Substanzen. Zigaretten-abstinent waren 10.4% und 19.5% gaben an, kein Cannabis mehr zu konsumieren. Kombinierte, Cotinin-validierte Abstinenz wurde von 5.2% der Teilnehmenden erreicht. Ausserdem nahm die Häufigkeit von Tabak- und von Cannabis-Konsum im Laufe der Studienphase ab. Die Haltequote lag bei 62.3%, wobei nur drei Teilnehmende den Kurs unter anderem wegen schwerer Probleme, die sich während des gleichzeitigen Rauchstopp(versuch)s entwickelten, abgebrochen haben. Hinweise auf Hospitalisierungen liegen jedoch nicht vor.

Da die Vorstudie auch nahegelegt hatte, dass die Bereitschaft von Co-Rauchenden, den Konsum beider Substanzen gleichzeitig aufzugeben, vermutlich eher mässig ist, wurden zusätzlich drei web-basierte, komplett automatisierte Kurzinterventionen entwickelt, die darauf abzielten, die Bereitschaft zum gleichzeitigen Tabak- und Cannabis-Rauchstopp zu erhöhen. Die erste dieser Interventionen war eine Kombination aus Selbsttest und personalisiertem, normativen Feedback, während die zweite Intervention Prinzipien der motivierenden Gesprächsführung einsetzte. Die dritte Intervention vermittelte lediglich Informationen über den Konsum von Tabak und Cannabis sowie den Co-Konsum beider Substanzen. In Paper 3 werden diese Interventionen anhand eines randomisierten Studiendesigns mit Prä-, Post- und Follow-up-Messung evaluiert. Insgesamt konnten 325

Personen den Interventionen zugewiesen und bei der Datenanalyse berücksichtigt werden. Zum Zeitpunkt der Post-Messung direkt nach der Intervention war die Bereitschaft zum gleichzeitigen Rauchstopp in der Gesamtstichprobe signifikant höher als vor der Intervention, $B = 0.33$, 95% CI [0.10, 0.56], $p = .006$. Für den Vergleich der Prä- mit der Follow-up-Messung wurde aber kein signifikanter Effekt gefunden. Ausserdem ergaben sich keine Unterschiede zwischen den verschiedenen Interventionen.

Gemäss der Befunde dieser Arbeit ist die gleichzeitige Behandlung von Tabak- und Cannabis-Konsum zumindest im Rahmen des untersuchten Rauchstopp-Programms machbar. Die Evaluation des Rauchstopp-Programms und der web-basierten Interventionen legte aber auch nahe, dass aufgrund der Komplexität von gleichzeitigem Intervenieren bei Tabak- und Cannabiskonsum möglicherweise intensivere Interventionen erforderlich sind, vor allem wenn andauernde Abstinenz von beiden Substanzen als Ziel angestrebt wird. Zukünftige Forschung sollte diese Komplexität berücksichtigen und die Wirksamkeit gleichzeitiger Behandlung von Tabak- und Cannabis-Konsum mittels randomisiert-kontrollierten Studien untersuchen.

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1. INTRODUCTION

The use of tobacco and cannabis is common worldwide with important consequences for health and quality of life. Tobacco smoking is the major preventable cause of premature death and among the three leading risk factors for the global burden of disease (Lim et al., 2012). Among the health consequences of tobacco use are respiratory diseases, cancer, and cardio-vascular diseases (Lim et al., 2012). The global past-month prevalence of tobacco use among the population aged 15 and above is 25.0% (UNODC United Nations Office on Drugs and Crime, 2012). Cannabis is the most prevalently used illegal drug worldwide with a global annual prevalence of 2.6% to 5.0% (UNODC United Nations Office on Drugs and Crime, 2012). Cannabis use is associated with adverse effects on mental and physical health as well as on educational and cognitive outcomes (Caldeira, Grady, Vincent, & Arria, 2012; Callaghan, Allebeck, & Sidorchuk, 2013; W. Hall & Degenhardt, 2009). Figures for Switzerland present a similar picture. Among the Swiss population aged 15 and above, 18.9% smoke tobacco daily and 7.0% are occasional tobacco smokers (Gmel, Kuendig, Notari, Gmel, & Flury, 2013). The 12-month prevalence rate of cannabis use is 6.3%, and 3.2% used cannabis during the 30 days preceding the survey (Gmel, Kuendig, et al., 2013).

Tobacco and cannabis use often co-occurs, i.e. tobacco users are more likely to use cannabis than tobacco-abstainers (Radtke, Keller, Krebs, & Hornung, 2011; Substance Abuse and Mental Health Services Administration, 2013) and vice versa (Richter et al., 2005; Rigotti, Lee, & Wechsler, 2000). The use of tobacco and cannabis is linked inextricably (Amos, Wiltshire, Bostock, Haw, & McNeill, 2004) and the connecting mechanisms are assumed to go beyond those that link co-use of drugs in general (Agrawal, Budney, & Lynskey, 2012). This unique relationship is relevant in the context of initiation and progression of tobacco and cannabis use, and is particularly pronounced in the context of cessation (Amos et al., 2004).

The body of literature on co-use of tobacco and cannabis is growing. In 2012, three reviews on co-occurring tobacco and cannabis use were published (Agrawal et al., 2012; Peters, Budney, & Carroll, 2012; Ramo, Liu, & Prochaska, 2012). Up to now, most publications are epidemiological studies and focus on the role of tobacco and cannabis use in the initiation and progression of either substance use. Fewer studies examined the relationship of tobacco and cannabis use in the context of cessation (see section 2.1.4). Some of them are observational studies analysing quit attempts and quit success of co-smokers compared to smokers of only one substance. Other studies examined the effectiveness of treatment that addresses only tobacco or cannabis use for co-smokers compared to single-smokers. However, there is a considerable lack of research on interventions for co-smokers. So far, only one small pilot study of an intervention tailored for co-smokers has been published (Hill et al., 2013). In addition, a few studies have examined brief interventions for universal drug prevention or early intervention which targeted tobacco and cannabis besides other drug use and health behaviour (McCambridge, Hunt, Jenkins, & Strang, 2011; McCambridge, Slym, & Strang, 2008; McCambridge & Strang, 2004, 2005). Promising results originate also from tobacco cessation interventions that are integrated into treatment of other substance use.

In their review, Ramo and colleagues concluded that "there is a great need to develop prevention and intervention programs that address the co-use of [tobacco] and [marijuana]" (Ramo et al., 2012, p. 114) and the authors of the other reviews reached similar conclusions (Agrawal et al., 2012; Peters et al., 2012). In line with this, the aim of the current thesis was to extend research on co-use of tobacco and cannabis by developing and evaluating interventions that are tailored for co-smokers of both substances.

First, a preliminary study was conducted to analyse the demand of an intervention for co-smokers of tobacco and cannabis and to collect suggestions for its design. The interviewed experts and co-smokers confirmed a demand for tailored interventions, but the readiness of co-smokers to stop tobacco and cannabis use simultaneously was expected to be modest.

Therefore, three brief, web-based motivational interventions were developed that aimed at enhancing co-smokers' readiness for a simultaneous quit attempt. Furthermore, an integrative group cessation course for co-smokers of tobacco and cannabis was developed. Three research articles (labelled Paper 1, 2, and 3) constitute the central part of this thesis. Paper 1 describes the results of the preliminary study, the developed smoking cessation intervention, and the results of its acceptability study. Paper 2 analyses the cessation course regarding its feasibility, safety, and initial effectiveness. Finally, Paper 3 evaluates the web-based motivational interventions.

In the following, the chapter *Background* provides an overview of the existing evidence on co-use of tobacco and cannabis in general and on interventions for tobacco and cannabis use in particular. Subsequently, the chapter *The Current Thesis* includes the research questions and summarizes the three papers. The following *General Discussion* illuminates the main findings according to the research questions. It also considers methodological aspects of the studies that form this thesis. Furthermore, an outlook on future research and implications for clinical practice is given. Finally, the three manuscripts are provided in full length.

2. BACKGROUND

2.1. The Relationship between Tobacco and Cannabis Use

2.1.1. Forms of Co-Occurring Tobacco and Cannabis Use

In general, multiple substance use can be subdivided in two forms, depending on the time-frame in which the substances are consumed (Earleywine & Newcomb, 1997). While *simultaneous use* refers to the use of two or more substances on a single occasion or sequentially close in time, *concurrent use* defines the use of two or more substances during lifespan or within a certain time period, e.g. within one year. Simultaneous use is therefore a sub-form of concurrent use (Martin, 2008).

In the case of tobacco and cannabis, simultaneous use can occur in two ways. First, both substances can be co-administered by smoking cannabis mixed with tobacco, i.e. mulling (cannabis-joints mixed with tobacco) or smoking blunts (cannabis in a cigar shell) (Sifaneck, Johnson, & Dunlap, 2005). Cannabis is often co-administered with tobacco to ensure that it burns smoothly (Patton, Coffey, Carlin, Sawyer, & Lynskey, 2005). Second, both substances can be used directly after each other which is referred to as c*hasing* cannabis with tobacco cigarettes or cigarillos (Sifaneck et al., 2005). In the empirical part of this thesis, the terms *co-smoking* and *co-smokers* refer to those who concurrently smoke both a tobacco product (cigarettes, tobacco pipes, cigars etc.) and a cannabis product (cannabis joint mixed with tobacco or pure cannabis joint).

2.1.2. Prevalence, Correlates, and Consequences of Co-Use

The co-use of tobacco and cannabis is one of the most common combinations of poly-drug-use in adolescents and young adults (Ramo et al., 2012). For Switzerland, no data are available on how many individuals show *any* concurrent use of tobacco and

cannabis. Instead, population surveys differentiate according to different variables such as use intensity and age group. According to the Swiss Addiction Monitoring, in 2012 18.9% of the Swiss population aged 15 and above were daily tobacco smokers, 7.0% smoked occasionally, 23.0% were former smokers, and 51.0% had never smoked tobacco (Gmel, Kuendig, et al., 2013). Regarding cannabis use, the lifetime, 12-month, and 30-day prevalence was 29.6%, 6.3%, and 3.2%. In the age-group of 15 to 19 years, 2.4% of the non-smokers reported frequent, i.e. at least weekly, cannabis use whereas the remaining 97.6% used cannabis either less frequently or not at all. In contrast, the prevalence of frequent cannabis use was higher among the occasional (12.0%) and the daily tobacco smokers (7.2%). Reciprocally, among those who did not report any cannabis use during the past 30 days, 18.3% were daily tobacco smokers. Among the occasional cannabis users the prevalence of daily tobacco smokers was 66.4% and among the frequent cannabis users it was 34.4%. How many of the remaining 33.6% and 65.6%, respectively, were occasional tobacco smokers and how many were non-smokers is not clear.

Concerning co-administration of tobacco and cannabis in Switzerland, a recent study among young men (Cohort Study on Substance Use Risk Factors, C-SURF) revealed, that smoking cannabis in joints is by far the most common way. Of the 5'990 participants, 30.7% had used cannabis during the 12 months preceding the survey (Baggio et al., 2013). Of these, 97.3% reported using joints with tobacco, either solely or together with other routes of administration. The second frequently applied routes were joints without tobacco (38.2%) and cannabis mixed with food (37.2%), followed by waterpipes with tobacco (29.3%) and without tobacco (24.0%). Furthermore, another study among Swiss cannabis users aged around 15 years found that even among cigarette abstainers the majority administers cannabis mixed with tobacco (Bélanger, Akre, Kuntsche, Gmel, & Suris, 2011).

While tobacco and cannabis use are clearly associated with each other, the factors which predict co-use are less clear (Ramo et al., 2012). In their review, Ramo and colleagues (2012) identified only few consistent correlates and consequences of co-use, namely African-American ethnicity, some mental and physical health characteristics (e.g. high-intensity pleasure temperament), and school characteristics (e.g. good grades) (Ramo et al., 2012). Furthermore, increased age was correlated with co-use. Concerning sex differences in the co-use of tobacco and cannabis, findings are not consistent (Ramo et al., 2012).

Findings regarding the association between co-use of tobacco and cannabis with severity of use are also inconsistent. However, co-users seem to have a greater likelihood of cannabis use disorders compared with cannabis-only users, but co-use does not seem to be consistently correlated with a greater likelihood of tobacco use disorders compared to tobacco-only users (Peters et al., 2012). Contrary to this, Agrawal and colleagues (2012) found elevated rates of nicotine dependence among those who had at least once used cannabis and higher rates of cannabis use disorders among those who had at least once smoked cigarettes. A study that analysed the way of cannabis administration revealed that using marijuana with tobacco (smoking blunts and chasing) was positively associated with the number of cannabis dependence symptoms (Ream, Benoit, Johnson, & Dunlap, 2008). One further study which analysed differential use frequency found that co-smokers smoked less tobacco compared to tobacco-only smokers but were using more cannabis than cannabis-only users (Bonn-Miller, Zvolensky, & Johnson, 2010).

As a consequence of co-occurring tobacco and cannabis use, several studies have fournd the exacerbation of mental health symptoms, such as depressive symptoms (Lee Ridner, Staten, & Danner, 2005) or a depression diagnosis (Boys et al., 2003). Furthermore, the majority of the studies that analysed risk behaviour (i.e. drug driving,

unsafe sex, high school drop-out) and neurocognitive impairment (i.e. memory, processing speed, nicotine reward/reinforcement) detected positive associations with co-use. Physical health effects of co-smoking are hardly known (Ramo et al., 2012). However, two studies indicate that co-use is associated with respiratory problems in young adulthood (Taylor et al., 2002; Taylor, Poulton, Moffitt, Ramankutty, & Sears, 2000), but it is unknown whether co-use results in chronic physical health problems (Ramo et al., 2012). Furthermore, it is unclear whether some adverse effects of tobacco use and cannabis use, respectively, are compensated and others are added or multiplied when tobacco and cannabis are used concurrently.

2.1.3. Mechanisms Underlying Co-Use of Tobacco and Cannabis

In their review, Ramo et al. (2012, p. 112) summarize: "Clearly, the use of one substance increases the likelihood of concurrent or future use of the other substance". However, the linking mechanisms are less clear, but they are assumed to go beyond the mechanisms underlying co-use of substances in general (Agrawal & Lynskey, 2009a). In the following, several mechanisms that link tobacco and cannabis use at multiple stages in their progression of use will be specified, whereas the next chapter will focus on the cessation of use among co-smokers. The relative importance of the presented mechanisms that contribute to co-use of tobacco and cannabis may vary across development (Agrawal, Silberg, Lynskey, Maes, & Eaves, 2010) and stages of use (Agrawal et al., 2012).

The *gateway hypothesis* (D. B. Kandel, 2002; D. Kandel, 1975) suggests that the sequence of drug use initiation is uniform and developmentally deterministic (Vanyukov et al., 2012). It assumes that the use of licit substances, i.e. tobacco and alcohol, is a gateway to cannabis use which then, in turn, "sets an individual on a trajectory to addiction to hard drugs" (Vanyukov et al., 2012, p. 54). In line with this

hypothesis, several studies found an increased likelihood of starting cannabis use among tobacco users compared to non-tobacco users (Agrawal & Lynskey, 2009b; Korhonen et al., 2010). Using the baseline and 18-month follow-up data of the C-SURF study, we also analysed this gateway sequence and found that cigarette use was among the strongest predictors of late onset of cannabis use among young men (Haug, López Núñez, Becker, Gmel, & Schaub, submitted)[1]. Furthermore, tobacco use also seems to predict progression of cannabis use to problematic cannabis use or dependence (Swift, Coffey, Carlin, Degenhardt, & Patton, 2008). However, several studies found also the reverse sequence, i.e. cannabis was used before tobacco and predicted the onset of tobacco use (Ford, Vu, & Anthony, 2002; Patton et al., 2005; Tullis, DuPont, Frost-Pineda, & Gold, 2003). This sequence is referred to as *reverse gateway* effect (Patton et al., 2005). Moreover, cannabis use can also predict progression to higher involved stages of tobacco use, such as daily cigarette use and nicotine dependence (Agrawal, Madden, Bucholz, Heath, & Lynskey, 2008; Patton et al., 2005; Timberlake et al., 2007). The results of a second analysis that we conducted with the C-SURF data are in line with these findings. Our analyses accounted for a comprehensive set of variables including demographic background, religion and religiosity, health and health behaviour, social context, licit substance use and illicit substance use other than cannabis, personality, and military training status. However, cannabis use was still one of the strongest predictors of onset of daily cigarette smoking (Becker, Schaub, Gmel, & Haug, in preparation)[2]. The Swiss Tobacco Monitoring study assessed the sequence of tobacco and cannabis onset among adolescents with co-occurring tobacco and cannabis use with retrospective self-reports. The major part (58%) had smoked tobacco

[1] The manuscript of this study has been submitted to a journal and can be requested from the author of this thesis.
[2] The manuscript of this study is available as a draft and can be requested from the author of this thesis.

first, 38% had used cannabis first, and 2% had simultaneously started with both substances, with a higher percentage of women reporting tobacco use first (69%) compared to men (51%) (Radtke, Keller, Krebs, & Hornung, 2008).

A competing concept is the *common liability* model. This assumes that not the use of a gateway drug puts an individual at risk for also using illicit substances such as cannabis but a common liability to using both licit and illicit drugs. This liability may include a genetic and individual vulnerability, such as proneness to deviancy and familial liability to addiction (van Leeuwen et al., 2011). The existing evidence concerning *genetic factors* suggests that there is a specific genetic overlap between liability to tobacco and cannabis use that extends beyond heritability of a general liability to externalizing problems and of a general propensity to drug use and misuse (Agrawal et al., 2012). However, environmental and not genetic factors seem to account for the largest variance in co-use of tobacco and cannabis (Ramo et al., 2012). P*eer influences* appear to be one factor that influences individual vulnerability. Analysing the origins of the correlation between tobacco, alcohol, and cannabis use among adolescents, an Australian study found an individual's vulnerability to substance use as an explaining factor (Lynskey, Fergusson, & Horwood, 1998). The vulnerability, in turn, was predicted by the extent to which the individual was affiliated with delinquent and substance using peers.

Another explanation for the normative sequence of drug use initiation is differential *availability* of tobacco and cannabis. Economic studies illustrate how availability may affect co-use. These studies indicate that tobacco and cannabis serve as complements, i.e. increasing cigarette prices result in decreasing cigarette and also decreasing cannabis use (Chaloupka et al., 1999; Farrelly, Bray, Zarkin, & Wendling, 2001), and vice versa (Cameron & Williams, 2001). Findings of the reversed sequence (i.e. cannabis use is initiated before tobacco use), however, exclude availability as the

only factor that contributes to the traditional sequence.

The *way of administration* is probably among the most important connecting mechanisms of tobacco and cannabis use. In the qualitative study of Amos and colleagues (2004), many participants made the experience that smoking joints, i.e. co-administration, served as gateway to smoking cigarettes. On the one hand, a quantitative study found that many of the participating college students learned inhalation through smoking marijuana (i.e. shared route of administration) and subsequently smoked both marijuana and tobacco (Tullis et al., 2003). The relevance of the way of administration is also underlined by a study of Agrawal and Lynskey (2009b) in which smoking tobacco was significantly associated with cannabis use and dependence whereas use of smokeless tobacco was not.

Due to the shared route of administration, tobacco smoking and cannabis smoking may serve as behavioural cue for each other and therefore reinforce each other (Agrawal & Lynskey, 2009a). Moreover, cross-drug reinforcement of tobacco and cannabis use happens also on a pharmacological level. Tobacco and cannabis affect the same neural pathways, with some systems being mutually enhanced by the two substances and others having contrasting effects (Viveros, Marco, & File, 2006) and nicotine may prolong and enhance the subjective effects of cannabis (Penetar et al., 2005; Tullis et al., 2003).

2.1.4. Cessation of Tobacco and Cannabis Use Among Co-Smokers

The following part summarizes the evidence on quit attempts and quit success among co-smokers. First, it presents findings from observational studies and findings from clinical interventions that targeted only one substance but measured also the use of the non-treated substance. Subsequently, it discusses potential reasons for impaired cessation outcomes.

While co-use of tobacco and cannabis seems to be associated with poorer cannabis cessation outcomes compared to cannabis-only use, there appears to be no consistent association with poorer tobacco cessation outcomes compared to tobacco-only users (Peters et al., 2012). Regarding tobacco cessation during *observational studies*, one study on 2033 adolescents found a decreased likelihood of successfully stopping tobacco smoking among those with a history of marijuana use (Abrantes et al., 2009). Similar results were found in a study that reassessed 431 tobacco smoking adults after 13 years (Ford et al., 2002). Those who had used marijuana during the 30 days preceding the baseline measurement made fewer attempts to quit tobacco and were more likely to still use tobacco at the follow-up, with daily marijuana use being even stronger associated with continued tobacco smoking. Contrary to these findings, a 10-year cohort study in Australia which followed 1943 adolescents initially aged 14-15 years into young adulthood found little evidence for an impact of cannabis use on the likelihood of smoking cessation (Patton et al., 2005). Longitudinal studies comparing cannabis quit attempts and quit success between cannabis-only users and co-users are lacking.

The evidence regarding differential success of co-smokers and smokers of only one substance in *single-interventions* is scarce because many single-treatment studies did not access the use of the not-treated substance or did at least not analyse its influence on treatment outcome. Moreover, use of other substances than tobacco is often an exclusion criterion in smoking cessation trials, leading to limited evidence on treatment success among co-smokers. However, most of the studies that took into account both substances have shown that co-smokers were less likely successful in tobacco-only interventions (Gourlay, Forbes, Marriner, Pethica, & McNeil, 1994; Stapleton, Keaney, & Sutherland, 2009) and cannabis-only interventions (de Dios, Vaughan, Stanton, & Niaura, 2009; Gray et al., 2011; Moore & Budney, 2001).

Nevertheless, several studies of single-interventions for tobacco cessation did not find such differences (Humfleet, Muñoz, Sees, Reus, & Hall, 1999; Metrik, Spillane, Leventhal, & Kahler, 2011). Methodological differences limit the comparability of the studies, e.g. not all studies accounted for baseline differences between the groups.

Several reasons might explain the lower quit rates of co-smokers. First, *motivational factors* seem to differ between co-smokers and smokers of only one substance. Co-smokers seem to be less likely to plan tobacco cessation compared to tobacco-only smokers (Ramo, Delucchi, Hall, Liu, & Prochaska, 2013). However, some findings indicate that co-smokers' motivation to quit cannabis use is even lower since cannabis appears to have a more positive functional value and is viewed as less harmful compared to cigarettes (Amos et al., 2004; Highet, 2004; J. P. Lee, Battle, Lipton, & Soller, 2010; Sifaneck et al., 2005).

A further potential explanation for the decreased likelihood among co-smokers to successfully quit tobacco and cannabis, respectively, is the already mentioned *cross-drug reinforcement* via the way of administration and common pharmacological processes (Agrawal et al., 2012). This is especially relevant when co-smokers try to quit only one substance, since each smoked cigarette or joint may cue the use of the substance intended to quit. Cross-drug reinforcement may also explain the substitution phenomenon which individuals often experience when trying to quit one substance, i.e. the increased use of the substance not intended to quit (Akré, Michaud, Berchtold, & Suris, 2010; Amos et al., 2004; Copersino et al., 2006; Haney et al., 2013).

One important barrier to single-cessation of tobacco or cannabis and in particular to simultaneous cessation is the experience of *withdrawal*. While tobacco withdrawal is well documented (Hughes, 2007), the existence of cannabis withdrawal has long been debated (Smith, 2002) and cannabis withdrawal has only been included in the new DSM-V (American Psychiatric Association, 2013). Growing evidence indicates that

cannabis withdrawal is common and clinically significant (Agrawal, Pergadia, & Lynskey, 2008; Budney & Hughes, 2006; Hesse & Thylstrup, 2013), and little doubt remains in the reliability and validity of the cannabis withdrawal symptom (Agrawal et al., 2012). On the one hand, tobacco and cannabis withdrawal share many symptoms, such as restlessness, difficulties with concentration, sleep difficulties, increased anger, and increased aggression (Budney, Vandrey, Hughes, Thostenson, & Bursac, 2008; Vandrey, Budney, Hughes, & Liguori, 2008). On the other hand, both have also unique symptoms: Irritability and decreased appetite are associated stronger with cannabis withdrawal, while increased appetite and craving are more typical for tobacco withdrawal (Budney et al., 2008). One study indicates that withdrawal during cessation of tobacco alone and cannabis alone is of a similar magnitude but stronger during simultaneous cessation (Vandrey et al., 2008). However, substantial individual differences were noted and the differences regarding the severity lasted only for two days.

2.2. Interventions for Tobacco and Cannabis Users

This chapter summarizes the existing evidence on interventions for tobacco and cannabis users. First, an overview presents the most established approaches for single-treatment of tobacco and cannabis use. Subsequently, evidence regarding their efficacy in the treatment of tobacco and cannabis use, respectively, is summarized. Next, tobacco cessation interventions that are integrated in interventions for other substance use are reviewed. Compared to integrated tobacco cessation interventions, evidence on the efficacy of combined treatment of cannabis and other problematic substance use is lacking. Subsequently, universal interventions for substance use which also target tobacco and cannabis use are presented. Finally, the only published evaluation of an intervention that explicitly targets co-users of tobacco and cannabis is introduced. Since

the interventions evaluated in Paper 3 of this thesis are web-based, the sections also touch the effectiveness of web-based interventions in the particular behaviour if appropriate evidence is available.

2.2.1. Overview of Psychotherapeutic Treatment Approaches

In the following, the most established approaches of face-to-face and web-based interventions for adult smokers of tobacco and/or cannabis are briefly summarised.

An established counselling technique for building motivation to change substance use behaviour is *motivational interviewing* (MI). MI is defined as "a client-centered, directive method for enhancing intrinsic motivation to change by exploring and resolving ambivalence" (Miller & Rollnick, 2002, p. 25). A particular *spirit*, based on the three elements *collaboration* between the therapist and the client, *evocation* of intrinsic motivation for change, and emphasizing the *autonomy* of the client, characterizes MI. Fundamental techniques are open-ended questions, affirmations, reflective listening, and periodical summaries. Methods such as using an importance ruler and exploring decisional balance aim to elicit change talk, i.e. statements by the client that express consideration of, or motivation for change (Miller & Rollnick, 2002).

Personalised, normative feedback interventions are based on the social norms approach (Perkins, 2003). They typically include self-assessment sections and feedback sections in which the participant's behaviour is compared to a reference sample. The overestimation of substance use of others is common and its degree is positively associated with one's own use (Bertholet, Faouzi, Studer, Daeppen, & Gmel, 2013). Social norm interventions built upon this association and aim to correct the client's erroneous perceptions.

Based on social learning theory, *cognitive behavioural therapy* (CBT) in substance abuse treatment assumes that drug dependence is at least in part an acquired

behaviour pattern (Stephens, Roffman, Copeland, & Swift, 2006). CBT is often combined with motivational enhancement interventions such as MI. A particular focus is put on relapse prevention (RP) (Marlatt & Gordon, 1985). RP aims at the identification and prevention of high-risk situations such as craving symptoms. Self-monitoring assignments are a common technique to identify personal high-risk situations and their antecedents. The development of cognitive and behavioural coping skills such as withdrawal management, relaxation techniques, and drug refusal skills is at the core of RP (Roffman & Stephens, 2005; Shiffman, Kassel, Gwaltney, & McChargue, 2005).

Contingency management (CM) interventions are used as adjuncts or as stand-alone treatment. Based on operant conditioning, they systematically provide incentives and disincentives to promote changes in substance use, therapy attendance, or medication compliance (Higgins, Silverman, & Heil, 2008).

Originally applied to treatment of alcohol use, the *Community Reinforcement Approach* (CRA) was later widened to other substances. It aims to replace environmental contingencies that have reinforced alcohol or drug use with prosocial activities and behaviours (Godley et al., 2001).

Web-based interventions for tobacco use are increasingly popular. Delivering interventions through the Internet has several advantages over face-to-face treatment. On the side of the client, the threshold to use web-based interventions is low given that their access is usually possible anytime and anywhere, that they are usually free of cost and can be accessed anonymously, and that their use is less stigmatized (Copeland & Martin, 2004). On the side of the public health system, costs are comparatively low, especially if interventions are fully automated. These kinds of interventions can be individually tailored by adaptive filtering and feedback but do not require treatment personnel. Among the most frequently applied techniques in web-based interventions is

the presentation of personalised, normative feedback (e.g. Doumas & Hannah, 2008; Haug, Meyer, & John, 2011). Furthermore, some web-based interventions are based on MI that is usually implemented as a chat-intervention rather than being delivered fully automated (e.g. Jonas, Tossmann, Tensil, Leuschner, & Strüber, 2012; Woodruff, Conway, Edwards, Elliott, & Crittenden, 2007).

2.2.2. Interventions for Tobacco Use

According to an overview of recent Cochrane reviews on single-interventions for tobacco addiction, behavioural support in combination with medication such as nicotine replacement therapy (NRT), bupropion, or varenicline is the most effective treatment approach (Hartmann-Boyce, Stead, Cahill, & Lancaster, 2013). Moreover, the reviews indicate that the efficacy of behavioural support exceeds the efficacy of pharmacotherapy. Both, group therapy compared with self-help only and individual counselling compared with minimal contact are effective (Hartmann-Boyce et al., 2013). However, differential effectiveness of group versus individual therapy has not been detected so far (Stead & Lancaster, 2009). Furthermore, mobile phone technology and training of health professionals in smoking cessation are effective in promoting tobacco cessation. With regard to motivational interventions, MI is superior to brief advice/usual care whereas stage based counselling and standard advice seem to be equally effective (Hartmann-Boyce et al., 2013).

A systematic review categorizes the evidence supporting the use of web-based smoking cessation interventions as insufficient to moderate in adults and insufficient in college students and adolescents (Hutton et al., 2011). The efficacy of web-based smoking cessation in adults seems to be modest and more personalized and intensive web-based interventions may be more effective regarding smoking cessation (Civljak, Stead, Hartmann-Boyce, Sheikh, & Car, 2013; Hutton et al., 2011).

2.2.3. Interventions for Cannabis Abuse and Dependence

For the treatment of cannabis use, a number of psychotherapeutic interventions such as CBT, motivational enhancement therapy, and social support interventions seem to be effective (Benyamina, Lecacheux, Blecha, Reynaud, & Lukasiewcz, 2008; Denis, Lavie, Fatseas, & Auriacombe, 2006; Nordstrom & Levin, 2007). No form of psychotherapy has shown superior effectiveness, with the exception of voucher-based interventions when used in combination with other effective psychotherapeutic interventions (Denis et al., 2006; Nordstrom & Levin, 2007). Furthermore, treatment length seems to have no association with treatment success (Nordstrom & Levin, 2007). For example, one randomized controlled trial compared 1) 4-session of relapse prevention in combinations with social support, 2) two sessions of individualized assessment and intervention including motivational enhancement and cognitive-behavioural techniques, and 3) a delayed treatment control group (Stephens, Roffman, & Curtin, 2000). Compared to the control group, participants of both intervention groups significantly reduced their cannabis use frequency. However, the two intervention groups did not differ regarding their effectiveness. Furthermore, both individual and group treatment of cannabis use has been found to be effective (Stephens et al., 2006). Contrary to the treatment of tobacco use, for cannabis use treatment no medication has been shown consistent effectiveness so far (Budney, Roffman, Stephens, & Walker, 2007). Moreover, while the usual goal of interventions for tobacco use is abstinence, interventions for cannabis abuse and/or dependence often aim at the reduction of use frequency. However, abstinence goals seem to predict better outcomes (Budney et al., 2007). Abstinence rates following cannabis treatment are relatively small (Denis et al., 2006). For continued abstinence, they vary between 15 and 37% (Haney et al., 2013). With regard to reduction, treatment among adolescents results in moderate reductions, with smaller effect sizes when follow-up periods were longer

(Bender, Tripodi, Sarteschi, & Vaughn, 2011).

Taking into account the increasing demand for cannabis treatment (European Monitoring Centre for Drugs and Drug Addiction, 2012), it is important to investigate web-based interventions for cannabis users. The first meta-analysis on Internet and computer based treatment of cannabis use has been published recently (Tait, Spijkerman, & Riper, 2013). The analysis of the data which were extracted from 10 studies revealed a small but significant pooled effect size at post-treatment. Hence, Internet and computer based interventions appear to be effective in reducing cannabis use at least in short-term.

2.2.4. Integrated Tobacco Cessation Interventions

For a long time, tobacco treatment was not included in substance abuse treatment settings. Tobacco treatment is by far not offered in every addiction treatment program, although individuals in substance abuse treatment have high tobacco use prevalence rates and a large proportion is interested in smoking cessation (S. M. Hall & Prochaska, 2009; J. J. Prochaska, Delucchi, & Hall, 2004). Fuller and colleagues (2007) mention several barriers to the integration of tobacco treatment in substance abuse treatment. Among them are the high cigarette smoking prevalence among treatment staff, a culture amenable to smoking, and attitudes of staff. One of these attitudes is the view that tobacco cessation has a lower priority because of its few immediate consequences in comparison to alcohol and non-nicotinic drugs. Prochaska and colleagues (2004) discuss a further important barrier is the concern of many clinicians that tobacco cessation would have detrimental effects on the outcomes of the primary treated substance (J. J. Prochaska et al., 2004).

Several reviews (Baca & Yahne, 2009; J. J. Prochaska et al., 2004; J. J. Prochaska, 2010; Richter & Arnsten, 2006) summarize the findings of smoking

cessation interventions during substance abuse treatment. Many of them are integrated tobacco cessation interventions integrated in treatment of alcohol dependence. According to the pooled analysis of Prochaska and colleagues (2004), intervention effects for smoking cessation were significant at short-term but not at long-term. However, contrary to the common concern, they found that smoking cessation interventions during addiction treatment seem to enhance rather than impair the outcome success of the substance abuse treatment. Baca and Yahne (2009) reported the same finding. Furthermore, more recent studies on the integration of tobacco cessation into treatment of alcohol dependence (Mueller, Petitjean, & Wiesbeck, 2012; Nieva, Ortega, Mondon, Ballbè, & Gual, 2010) and opioid dependence (Dunn, Sigmon, Reimann, Heil, & Higgins, 2009) revealed similar results.

2.2.5. Interventions Targeting at Multiple Behaviours Including Tobacco and Cannabis Use

In the following, several multiple behaviour interventions that target tobacco and cannabis use besides other health behaviours are presented. However, none of these studies explicitly took into account co-occurring tobacco and cannabis use.

McCambridge and colleagues (McCambridge et al., 2011, 2008; McCambridge & Strang, 2003, 2004, 2005) evaluated several brief interventions targeting tobacco and cannabis use among other substances. One study analysed a 1-hour single-session intervention that was adapted from MI and structured by a series of topics (McCambridge & Strang, 2004). The intervention targeted at young people between 16 and 20 years and was conducted in their school classes. Compared to the control group (‘education-as-usual’), the participants of the intervention group significantly reduced their use of cigarettes, alcohol, and cannabis at the 3-month follow-up. Although these differences had disappeared at the 12-month follow-up, significant improvements over

time were detected in the intervention group: those who had smoked cigarettes and those who had used cannabis at baseline had a decreased frequency of cigarette and cannabis, respectively (McCambridge & Strang, 2005). In two further studies, McCambridge and colleagues compared the effectiveness of a single-session of individual MI with individual psychoeducation (McCambridge et al., 2008) and with classroom advice (McCambridge et al., 2011). In both studies, no differences in the effectiveness of the interventions were found, but all participants had significantly reduced their use of tobacco, cannabis, and alcohol over time.

Werch and colleagues (Werch, Moore, DiClemente, Bledsoe, & Jobli, 2005; Werch et al., 2011) evaluated two brief integrative multiple behaviour interventions among high school students. The first intervention ("Project SPORT") consisted of a health behaviour screen, a one-on-one consultation lasting around 12 minutes, a take home fitness prescription and a reinforcing follow-up flyer. The minimal intervention control comprised a wellness brochure provided in school and a pamphlet about teen health and fitness mailed to the home. A total of 604 participants were randomized to one of the conditions. The results revealed significant positive effects for cigarette and marijuana use both at the 3-month and the 12-month follow-up (Werch et al., 2005).

The intervention ("Project Active") was evaluated with 479 students and consisted in a one-on-one consultation lasting on average 30 minutes. This included assessment and personalized feedback on fitness including tobacco, alcohol and illegal drug use. Participants of the control condition received a booklet about wellness in adolescents. While participants of the intervention significantly reduced their alcohol use frequency and quantity and improved their fruit and vegetable intake as well as their stress management, no significant reduction in tobacco or marijuana use was detected at the 3-month follow-up. Marijuana use increased in both groups, but this difference was not significant. The authors explained the lack of significant effects for cigarette use with

the small sample of cigarette users ($n = 34$). As possible explanation for the results regarding marijuana use, they mentioned differential attrition among marijuana users and that the intervention did not address marijuana use specifically but illegal drug use more general (Werch et al., 2011).

In general, web-based interventions targeting several health behaviours simultaneously have shown promising effects (Krebs, Prochaska, & Rossi, 2010). However, to the best of the author's knowledge multiple behaviour interventions that also target tobacco use in a web-based setting have not yet been evaluated.

2.2.6. Treatment Tailored to Co-users of Tobacco and Cannabis

So far, only one intervention that is tailored explicitly to co-smokers of tobacco and cannabis has been published (Hill et al., 2013). So far, it was only evaluated in a small pilot study. It is important to note that this intervention was not yet published when we conducted the preliminary study, conceptualized and implemented the interventions that are evaluated in this thesis. The intervention consisted of individual CBT sessions that were delivered during 10 weeks in combination with transdermal patch NRT. A target quit date for both substances was set after the first CBT session. Of the 12 participants who started the treatment, seven completed the treatment and were analysed regarding changes in use frequency of tobacco and cannabis. The participants significantly reduced their tobacco cigarette use from 12.6 cigarettes per day at baseline to 2.1 at the end of treatment. The change in cannabis use from 10.0 to 8.0 inhalations per day was not significant. No follow-up assessment was reported.

Up to now, neither motivational nor behavioural web-based interventions that target co-smokers have been published so far.

3. THE PRESENT THESIS

3.1. Overview and Research Questions

In this chapter, the three manuscripts that constitute the central part of this thesis are briefly summarized. The first step in the development of the interventions was a preliminary study including a demand analysis. Because this confirmed great interest in a cessation intervention for co-smokers, we proceeded with designing and implementing a group cessation program according to suggestions collected in the preliminary study. Paper 1 reports the results of the preliminary study and also gives a detailed description of the intervention design. In addition, Paper 1 already includes ratings of intervention acceptability that were assessed among participants after the last course session and among course instructors after all courses had been conducted. Paper 2 evaluates the group cessation intervention in terms of feasibility and initial effectiveness, using a within-participants design with pre-, post-, and 6-month follow-up assessments. The demand for the intervention (Paper 1) was accompanied by only modest readiness for simultaneous cessation among co-smokers, which led to the development of three brief web-based motivational interventions that aimed to enhance co-smokers' readiness to simultaneously quit tobacco and cannabis use. These web-based interventions are evaluated in Paper 3 using a randomized trial with pre-, post-, and 8-week follow-up assessments.

The papers address the following research questions:

Q1. Is there a demand for interventions that are tailored to co-smokers of tobacco and cannabis? (addressed in Paper 1)

Q2. Is the cessation intervention for co-smokers of tobacco and cannabis feasible? (addressed in Paper 1 and 2)

Q3. Can brief web-based interventions enhance co-smokers' readiness to quit simultaneously and what kind of web-based intervention is most effective? (addressed in Paper 3)

Q4. How do combined interventions for tobacco and cannabis use affect substance use? (addressed in Paper 2 and 3)

Q5. What has to be considered when targeting tobacco and cannabis use simultaneously? (addressed in Paper 1, Paper 2, and 3)

3.2. Summary of Paper 1

Development of an integrative cessation program for co-smokers of cigarettes and cannabis: demand analysis, program description, and acceptability study

Tobacco and cannabis use are strongly interrelated, but current national and international cessation programs typically focus on one substance, and address the other substance either only marginally or not at all. Paper 1 aimed to describe the development and content of the first integrative group cessation program (ISCP) for co-smokers of cigarettes and cannabis.

First, a preliminary study was carried out to investigate the demand for, and collect suggestions for the design of an ISCP. Therefore, expert interviews, user focus groups with (ex-)smokers, and an online survey were conducted. In general, the study revealed that both experts and co-smokers considered an ISCP to be useful but expected only modest levels of readiness for participation. Only half of the co-smokers responding to the online-survey thought that smoking tobacco and cannabis was interrelated but 68% confirmed the need of a dual-cessation intervention. Although only 28% felt ready to quit both substances simultaneously, 41% felt ready to participate at an ISCP. A logistic regression analysis revealed three significant predictors of readiness to quit tobacco and cannabis simultaneously: higher age, frequent (at least weekly) use of cannabis, and agreement with the statement "Cannabis is harmful to my health" were positively associated with readiness for a simultaneous cessation attempt. Regarding the intervention design, co-smokers of the focus groups stressed the importance of appropriate knowledge transfer concerning the interrelationship between both substances. For a group cessation intervention they suggested

that all participants should form a common goal for the intervention. Given that the experts believed that dual-cessation was more complex and demanding than single-cessation, they suggested that an ISCP should offer comprehensive medical, psychiatric and psychotherapeutic support.

Based on the findings of the preliminary study and of previous literature, an interdisciplinary team developed a treatment manual for an ISCP tailored to co-smokers who smoke tobacco products (e.g. cigarettes, pipes) at least daily and cannabis at least weekly. Two local addiction treatment centres in the Swiss cities of Zurich and Winterthur offered the courses. At an information evening, the two course instructors who guided the particular course presented the course program and background information, especially stressing the relationship between tobacco and cannabis use and the underestimated physical harms of cannabis use. In order to generate a low threshold intervention, the course consisted of only five to six weekly group sessions, a revival meeting after approximately six weeks, and one individual counselling session on request. Additionally, participants received a workbook and a smoking diary. The intervention based on principles of MI and CBT, on self-control practices and on the relapse-prevention model. Furthermore, participants were encouraged to use NRT or varenicline. The course aimed at dual abstinence with a common quit date at the third course session. Simultaneous cessation was preferred to sequential in order to avoid that the continued smoking of one substance cues the re-use of the one that was quit first.

During two implementation phases that lasted nine months in total, three 5-session courses (implementation phase 1) and four 6-session courses (implementation phase 2) were carried out with a total of 77 participants. At the end of treatment, 59 participants completed questionnaires that included items to measure the participants' opinion towards the intervention. The eight course instructors received an analogous questionnaire after they had conducted the last course. On a scale ranging from 0 to 5 with higher values indicating more positive evaluations, the participants (M = 3.9, SD = 1.1) and the course instructors (M = 4.3,

SD = 0.5) rated the course in general positively. Both the participants (*M* = 4.1, *SD* = 1.1) and the course instructors (*M* = 4.3, *SD* = 0.9) particularly appreciated the module "Analysis of the consumption diary" which was usually accompanied by an extensive group discussion. Participants of the implementation phase 2 with six instead of five course sessions tended to higher ratings than phase 1 participants. Furthermore, participants and course instructors valued those modules that aimed at developing concrete strategies for simultaneous cessation.

3.3. Summary of Paper 2

Feasibility, safety, and initial effectiveness of an integrative group cessation intervention for co-smokers of tobacco and cannabis

This study evaluated the feasibility, safety, and initial effectiveness of the ISCP, using a within-participants design with pre-, post-, and 6-month follow-up assessments. Two addiction treatment centres in Zurich and Winterthur, Switzerland, conducted seven group courses with a total of 77 participants. The inclusion criteria were (1) an age of 18 years or older; (2) daily tobacco cigarette, pipe, or cigar smoking; and (3) cannabis smoking at least once per week. The primary outcomes included cigarette use frequency, cannabis use frequency, and dual-abstinence at the 6-month follow-up assessment with 7-day timeline follow-back questions (Hjorthøj, Hjorthøj, & Nordentoft, 2012). Dual-abstinence was achieved if neither cigarette nor cannabis use was reported, and salivary cotinine was used to analytically verify self-reported dual-abstinence.

Abstinence from cigarettes, cannabis, or both was reported by 41.5% of the participants at the end-of-treatment (EOT) and by 23.4% at the 6-month follow-up assessment. For each substance separately, self-reported abstinence rates were 32.5% (EOT) and 10.4% (follow-up) for cigarettes and 23.4% (EOT) and 19.5% (follow-up) for cannabis. Cotinine-validated dual-abstinence was achieved by 13.0% (EOT) and 5.2% (follow-up). Generalised estimating equations (GEEs) revealed that tobacco use frequency (p = .001) and cannabis use frequency

($p < .001$) decreased significantly over the study period. Furthermore, all secondary outcomes improved significantly over time (problem drinking: $p = .003$; cigarette dependence, cannabis use disorder symptoms, depression, anxiety: all $p < .001$). Among participants who quit only one substance no evidence of a compensatory increase in the use of the other substance was found. The treatment retention rate was 62.3%, and participant satisfaction at the EOT assessment was high. On a scale ranging from 0 ("definitely no") to 5 ("definitely yes"), the majority of the 57 responding participants (33, 57.9%) chose the highest value of 5 ($M = 4.2$, $SD = 1.1$). Only three people reported that among their reasons for discontinuing the treatment was the experience of severe problems (i.e. problems with concentration and sleeping, depressive symptoms, or distorted perception) that emerged during their simultaneous cessation (attempt). We did not find evidence of hospitalisation due to course participation.

In conclusion, the evaluated group cessation program for co-smokers of tobacco and cannabis is feasible and comparatively safe. Testing this interventional approach within a randomized controlled trial would be reasonable. Nevertheless, the finding that three participants experienced severe problems due to their simultaneous cessation (attempts) must be addressed when implementing the program in the future.

3.4. Summary of Paper 3

Effectiveness of different web-based interventions to prepare co-smokers of tobacco and cannabis for double-cessation: a three-arm randomised trial

According to the results of the preliminary study presented in Paper 1, co-smokers' readiness for simultaneous cessation of tobacco and cannabis use is only modest. Thus, the question of how co-smokers can be motivated for a simultaneous cessation attempt had occurred. Because of its easy access and ubiquitous presence, the Internet arose as a potentially effective medium to reach a large number of co-smokers who might be unaware of the relationship between their tobacco and cannabis use. We developed three web-based and fully automated

interventions according to therapeutic approaches that are used for motivational enhancement in substance users. The first intervention combined the assessment of cigarette dependence and problematic cannabis use with personalised, normative feedback. The second intervention was based on principles of MI. As an active psycho-educational control group, the third intervention merely provided information on tobacco, cannabis, and the co-use of the two substances. To keep the threshold for intervention access and the study dropout rate as low as possible, the interventions were designed as brief single-session interventions.

Within a randomized trial with pre-, post-, and 8-week follow-up assessments, the interventions were evaluated regarding their efficacy to enhance readiness to simultaneously quit tobacco and cannabis, as measured with a readiness ruler (Biener & Abrams, 1991). Secondary outcomes were cigarette and cannabis use frequency, measured at baseline and after eight weeks. A total of 2467 website-users were assessed for eligibility of tobacco and cannabis co-use and 325 participants were finally randomized to the interventions and included in the analyses.

For the post-intervention assessment, GEEs revealed a significant increase in the readiness to quit tobacco and cannabis in the total sample, $B = 0.33$, 95% *CI* [0.10, 0.56], $p = .006$. However, this effect was not significant for the comparison between baseline and follow-up assessment ($p = .69$). Furthermore, no differential effects between the intervention types were found. Moreover, there were no significant intervention type or time effects for the frequency of tobacco or cannabis use.

In can be concluded that, in the arising field of dual interventions for co-smokers of tobacco and cannabis, brief web-based interventions can increase short-term readiness to quit tobacco and cannabis simultaneously. However, the personalised techniques were not more effective than psychoeducation and the interventions did not change frequency of tobacco and cannabis use.

4. GENERAL DISCUSSION

In the following, the results presented in the three papers will be integrated in an overall discussion of the research questions and methodological aspects. Finally, implications for clinical practice and for future research are derived based on the current findings.

4.1. Discussion of the Major Results

Three research articles describing the development and evaluation of web-based motivational interventions and a smoking cessation intervention for co-smokers of tobacco and cannabis constitute the basis of this thesis. These interventions are among the first that are explicitly tailored to co-smokers of tobacco and cannabis, a target group that has been ignored in intervention research so far. In the following, the studies' results are discussed against the background of the research question formulated in section 3.1.

Q1. Is there a demand for interventions that are tailored to co-smokers of tobacco and cannabis? (addressed in Paper 1)

The preliminary study confirmed a need for interventions addressing tobacco and cannabis simultaneously (Paper 1). This is in line with the conclusion that the authors of recent reviews have drawn (Agrawal et al., 2012; Peters et al., 2012; Ramo et al., 2012). These conclusions were based on the finding that no such interventions exist so far and on evidence indicating that single-interventions tend to be less effective for co-smokers than for users of either tobacco only or cannabis only. The current demand analysis was the first examining the perceived need among co-smokers themselves and experts including practitioners, i.e. potential providers of such treatment. Among the reasons for the lack of combined interventions for tobacco and substance use is the fact that clinicians prioritized the treatment of non-nicotinic substance use for a long time (S. M. Hall & Prochaska, 2009). Thus, the

finding that the practitioners in the current demand analysis clearly perceived a need for a combined intervention may reflect a change in attitudes towards the combined treatment of tobacco and cannabis use.

Q2. Is the cessation intervention for co-smokers of tobacco and cannabis feasible? (addressed in Paper 1 and 2)

So far, no comparable intervention has been published and the only small pilot study that analysed a dual-cessation intervention was conducted in an individual setting and published after the implementation of the ISCP. Thus, it was necessary to first evaluate the developed ISCP regarding its feasibility rather than directly conducting a large scale randomized controlled trial to determine efficacy. Although no consensus on the evaluation of feasibility exists (Arain, Campbell, Cooper, & Lancaster, 2010; Bowen et al., 2010), Bowen and colleagues identified several indicators commonly used to measure feasibility. These are acceptability, demand (e.g. perceived demand and actual use), implementation (e.g. success or failure of execution, resources needed for implementation), practicability (e.g. efficiency, positive/negative effects on participants), adaptation (e.g. degree to which similar outcomes are obtained in a new intervention format), integration (e.g. perceived fit with infrastructure), expansion (e.g. fit with organizational goals and culture), and limited efficacy (e.g. does the program/intervention show promise of being successful with the intended population).

Overall, the findings of the ISCP evaluation support its feasibility. Regarding *acceptability*, both participants and course instructors highly accepted the ISCP (Paper 1) and those participants returning the follow-up questionnaire were still satisfied with the intervention (Paper 2). *Demand* is supported by the findings of the preliminary study revealing that both experts and co-smokers perceived a demand for an ISCP (Paper 1, see discussion of research question Q1 above). Furthermore, Paper 2 illustrated that the ISCP was actually used by its target group. The planned sample size of 80 was reached (83 participants

participated in the ISCP, 6 of which were excluded from the analyses, see Paper 2). The *implementation* took place without any problems and was concluded two months faster than planned. Regarding *practicability*, the group setting as a resource saving treatment format turned out to be appreciated by the participants and course instructors, as indicated by the positive evaluation of the group discussion which took up nearly half of the time of each course session (Paper 1). Although at least three participants discontinued the course due to severe problems (i.e. problems with concentration and sleeping, depressive symptoms, and distorted perception), we found no evidence of hospitalisation due to course participation, suggesting that the intervention is considerably safe. Presumably, the advantages of outpatient treatment, e.g. cost-effectiveness and accessibility, outweigh adverse events as those reported by some participants of the ISCP. Possibilities to minimise such negative effects are discussed in section 4.4. The indicator *adaptation* is not applicable since no comparable intervention has been carried out so far. Concerning *integration* and *expansion*, the implementation of the courses in two treatment centres was successful. According to reports of the course instructors (not reported in this thesis), both centres previously had experienced the implementation of group interventions as disappointing because recruitment was difficult and treatment attrition high. Therefore, they were content using the ISCP and intend to implement the ISCP in the future. Finally, *limited efficacy* (in Paper 2: *initial effectiveness*) is supported by a retention rate of 62% and the findings that frequency of tobacco and cannabis use, nicotine dependence as well as problematic cannabis and alcohol use decreased. Furthermore, mental health improved over the study period (Paper 2).

However, whether observed positive changes and the achieved abstinence rates are really caused by the ISCP and whether the ISCP is more effective than a single-cessation intervention can only be determined with a randomized, controlled study. The effect of the ISCP on substance use behaviour is also discussed below in the context of research question Q4.

Furthermore, the generalizability of our feasibility findings is limited to the group setting. Also, the ISCP was developed for and implemented with adults, as was the intervention in the USA (Hill et al., 2013). Therefore it is not possible to draw a conclusion regarding the feasibility of dual-cessation interventions for adolescents. An appropriate intervention for this target group would have to be adapted to the particular situation of adolescent co-smokers. One possibility is to include the family in the treatment, as it is done in multidimensional family therapy (MDFT). This approach seems to produce superior treatment outcomes than individually-focused CBT (Liddle, Dakof, Turner, Henderson, & Greenbaum, 2008), in particular among youths with more severe drug use and psychiatric comorbidity (Henderson, Dakof, Greenbaum, & Liddle, 2010).

Q3. Can brief web-based interventions enhance co-smokers' readiness to quit simultaneously and what kind of web-based intervention is most effective? (addressed in Paper 3)

The within-subjects comparison of Paper 3 revealed a significantly higher readiness to quit simultaneously at the post-intervention assessment compared with the baseline assessment. The comparison between baseline and follow-up did not show a significant time effect. These results indicate that the three web-based interventions are effective in increasing the readiness for simultaneous cessation at short-term. Furthermore, between-groups analyses showed no significant differences between the three interventions. However, due to the study design not including an assessment-only, condition effects of the assessment procedure and intervention effects cannot be disentangled. Section 4.2 discusses this methodological aspect in more detail.

Both the lack of differences between the three types of interventions and the significant time effect at short-term are in line with a study on web-based interventions separately targeting problematic alcohol users and problematic cannabis users (Jonas et al., 2012). In this study, a single-session of chat-based MI was compared with a chat providing participants with

technical information about the baseline self-test. However, comparability with the study of this thesis is limited because the interventions in the study by Jonas and colleagues targeted only one behaviour and were not delivered in a fully automated manner.

Q4. How do combined interventions for tobacco and cannabis use affect substance use behaviour? (addressed in Paper 2 and 3)

While participants of the cessation intervention significantly reduced their use frequency of tobacco and cannabis over time (Paper 3), the within-subjects analyses of the web-based motivational interventions failed to reach significance (Paper 2). However, the interventions presented in the two papers differed regarding their goal and intensity. The web-based motivational interventions were very brief interventions and aimed primarily at enhancing readiness to quit simultaneously, whereas the ISCP supported the participants during several weeks including a wide range of behavioural treatment strategies promoting cessation or, if not possible, reduction of use. Therefore, the difference between the interventions regarding this outcome is not surprising.

It cannot be excluded that external factors could also have caused the observed change in substance use behaviour among the ISCP participants because we did not compare the intervention with an assessment-only or a delayed treatment control group.

In general, it is difficult to compare the results presented in this thesis with other studies because only one other study examining an intervention for co-smokers has been published so far (Hill et al., 2013). The smoking cessation intervention presented in this thesis and its evaluation differ also from the pilot study by Hill and colleagues. For instance, the ISCP has been conducted in a group rather than an individual treatment setting and it has been evaluated with a larger sample including relevant outcomes like dual abstinence that not have been reported by Hill and colleagues. Regarding tobacco use outcomes, the comparability between the ISCP and tobacco interventions integrated in substance abuse treatments (see

section 2.2.4) is also limited due to the lower priority usually assigned to the integrated tobacco cessation compared to the primary substance participants were seeking treatment for (S. M. Hall & Prochaska, 2009). Furthermore, the integrated interventions were often conducted in inpatient settings.

Q5. What has to be considered when targeting tobacco and cannabis use simultaneously?

In the preliminary study, several suggestions concerning important issues to be considered when developing a combined intervention were collected a priori. In addition, Paper 2 and Paper 3 allow for posteriori conclusions in terms of lessons learned during the implementation of the interventions.

The results of the preliminary study indicate that the recruitment strategy is crucial for a combined cessation intervention as both the experts and the co-smokers expected a low readiness to participate in such an intervention. Thus, the recruitment was planned thoroughly and two strategies were applied. The first was to spread the information of the new cessation course as wide as possible. This was mainly done by distributing leaflets and brochures and stimulating reports in newspapers and radio stations. The second strategy was to built motivation by informing about issues that were not widely known among the co-smokers participating in the preliminary study. That is, the strong relationship between tobacco and cannabis use and the potential physical harm of smoking cannabis were particularly stressed during the information evenings offered to potential participants. The finding, that within the preliminary study fewer online survey respondents had negative attitudes towards cannabis than towards tobacco use is in line with other studies reported in section 2.1.4 (Amos et al., 2004; Highet, 2004; J. P. Lee et al., 2010; Sifaneck et al., 2005). However, whether the emphasis on these issues has influenced the recruitment success cannot be determined. Furthermore, a review of interventions for recruiting smokers into cessation programs revealed that text messages indicating scarcity of places available were an effective

intervention (Marcano Belisario, Bruggeling, Gunn, Brusamento, & Car, 2012). The information evenings during the first implementation phase of the GCP were extremely well frequented which might have been the result of the big media interest and the reports in popular newspapers. As a consequence, the available spaces actually were scarce – although a parallel group was spontaneously organized. This scarcity possibly influenced participation similarly to the study cited above.

The results of the preliminary study also indicate that readiness to quit tobacco and cannabis simultaneously is modest. As this might be an obstacle both to spontaneous quit attempts and the participation in a combined cessation intervention, as well as to quit success, motivational strategies are important for combined interventions. The results of Paper 3 indicate that web-based interventions enhance co-smokers' readiness to quit simultaneously in the short-term. Furthermore, the structure of the cessation intervention also accounted for the need of motivation building by applying motivational strategies at the information evening and by setting the quit date only at the third course session. However, again it is not possible to determine the effectiveness of these strategies regarding participation at the intervention.

Combined interventions should account for the complexity of changing two behaviours simultaneously. All three papers pointed out this issue. In Paper 1, the experts and co-smokers participating in the preliminary study pre-estimated that simultaneous cessation was especially demanding and complex. Furthermore, the analyses of the web-based interventions did not reveal significant reductions in tobacco and cannabis use frequency, indicating that the web-based interventions may have been too brief to promote behaviour change (Paper 3). Finally, the finding that three participants of the ISCP experienced severe problems underlines the complexity of simultaneous cessation (Paper 2). Prolonging the treatment is a possibility to address this complexity and would be in line with the evidence that the efficacy of tobacco interventions increases with their intensity (Fiore et al., 2008). Furthermore, a study comparing intensive smoking cessation with usual care for smoking cessation among alcohol-

dependent smokers found a higher short-term smoking quit rate for the intensive intervention (Carmody et al., 2012). The finding that co-smokers participating in the second implementation phase with six instead of five course sessions rated the ISCP more positively additionally indicates that a longer treatment may be more appropriate (Paper 1).

4.2. Discussion of Methodological Aspects

An overall aspect important in all studies with co-users of tobacco and cannabis is the definition, the measurement, and the analyses of the term co-use. This is especially difficult when co-use is defined as it is in this thesis, i.e. as co-smoking of cigarettes (or similar tobacco products) AND cannabis (administered either with or without tobacco). One difficulty of this definition was that participants reporting cigarette-abstinence may still have been using tobacco in joints and therefore could not be defined as tobacco-abstainers. Although we assessed the most common way of cannabis administration, we could not exclude that those reporting tobacco-free administration were not using other forms of administration from time to time. The recent publication on routes of administration among the C-SURF study participants indicates that often different ways of administration are combined (Baggio et al., 2013). As a consequence of our definition, we also could not analytically verify self-reported cigarette-abstinence of ISCP participants because this would have resulted in false-negative testing among those who still used cannabis and administered it with tobacco (Paper 2). The objective validation of self-reported cannabis-abstinence constitutes a further problem, especially in studies of low-threshold interventions refraining from collecting urine samples. A further barrier to using analytical methods in validating cannabis abstinence was that the follow-up data was collected via post. So far, methods of salivary delta-9-tetrahydrocannabinol (THC) that are both valid and applicable under this sampling and transport conditions are lacking (D. Lee & Huestis, 2013).

Furthermore, several methodological aspects are shared by Paper 2 and 3. First, the

parallel implementation of the web-based interventions and the ISCP has to be considered. It would have been interesting to analyse whether the web-based interventions had an influence on participation at the ISCP or on treatment success. Initially these analyses were planned. However, it was not possible to conduct them in a reliable manner because a one-to-one assignment of the participants of the web-based interventions to those of the ISCP was impossible. In order to ensure anonymity, both interventions required the participants to create a personal code according to a rule combining certain letters of the parents' names and their own date of birth. Nevertheless, during the implementation of the ISCP it became evident that some participants provided different codes at different measurements although the combination rule was included in every questionnaire. Thus, even the matching within each intervention was difficult although possible. In the ISCP the groups of participants were small and the questionnaires could be matched according to the date they were filled in. In the web-based interventions study the telephone interviewers directly matched those participants of the web-based interventions that were followed-up via telephone calls. Those who filled out the online survey received the corresponding link in an email that was sent eight weeks after the baseline assessment. Therefore, they could also be matched according to the date the survey was filled out at. However, matching the participants between the interventions would have been unreliable.

A further common aspect of Paper 2 and 3 has already been mentioned: Neither the web-based interventions nor the ISCP included an assessment-only or a delayed-treatment control group. Because of the brevity of the web-based interventions with a length of 18 to 29 minutes including baseline and post-intervention assessments, an assessment-only condition would not have been feasible. A delayed-treatment control group, however, would likely have created a high attrition rate due to the low-threshold and non-binding study setting. The conclusion that the three web-based interventions are effective in enhancing co-smokers readiness to quit simultaneously therefore remains tentative. Regarding the ISCP, a control

group was not included because the main goal of the study was to analyse feasibility rather than effectiveness, as this was the first intervention of its kind. It can therefore not be excluded that other factors than the intervention caused the decreases in substance abuse and related problems and the increases in mental health that were observed during the study time.

Finally, it has to be considered that the sample sizes in Paper 2 and Paper 3 were reduced through intervention drop-out and study attrition, i.e. loss to follow-up. This was addressed by using GEEs for the analysis of changes over time because this method does not require complete data on all subjects (Arndt, 2009; Twisk, 2013). As the attrition rate in the web-based interventions was particularly high, in Paper 3 missingness was additionally addressed by applying multiple imputations which take into account the uncertainty surrounding missing data (Arndt, 2009). By including a wide range of predictors (i.e. baseline variables and post-intervention variables with low rates of missingness) in the imputation model, missing data can be estimated more accurately (Heeringa, West, & Berglund, 2010). Still, the results concerning changes of readiness to quit simultaneously and substance use frequency between the baseline and the follow-up assessment should be interpreted cautiously. For several reasons, the technique of multiple imputations was not applied in the analyses of the ISCP (Paper 2). First, contrary to the analysis of the web-based interventions, the analysis of the ISCP did not include between-groups comparisons where differential loss to follow-up can confound results regarding intervention effectiveness. Second, due to the small sample size only a small number of predictors could have been included in the imputation model, resulting in less reliable estimations. However, by reporting abstinence rates determined with two methods, i.e. complete case analysis and missings being treated as non-abstainers, the "true" abstinence rates can be estimated. They are in between the two reported rates, as complete case analyses provide too positive estimations and the treatment of all missings as non-abstainers is a too conservative approach.

4.3. Implications for Clinical Practice

The results of this thesis have several clinical implications. The most important one is that combined treatment of tobacco and cannabis use in adult co-smokers is feasible and is likely to result in reduced tobacco and cannabis use or even abstinence (Paper 2). However, simultaneous cessation is complex and co-smokers that attempt to quit both substances should be guided in both behaviour changes. Co-smokers that quit only one substance, either on their own or in the context of single-interventions, often report a substitution effect (Paper 1, Akré, Michaud, Berchtold, & Suris, 2010; Amos et al., 2004; Copersino et al., 2006; Haney et al., 2013). As indicated by the subgroup analyses in Paper 2, participants of the ISCP that quit one substance successfully did not increase the use frequency of the other substance. Thus, targeting both substances simultaneously can avoid a substitution effect among those who quit only one substance successfully. It also has to be considered that few co-smokers may experience severe problems such as depressive symptoms during a simultaneous cessation attempt. Therefore, clinicians should adequately inform co-smokers in advance about problems that might possibly arise during simultaneous cessation and develop strategies to prevent such experiences or strategies to cope with them if prevention fails (Paper 2). Several findings of this thesis also stress the importance of intensive knowledge transfer concerning the relationship between both substances and the health risks of cannabis use in order to built up motivation for change (Paper 1, 2, 3).

Furthermore, the evaluation of the ISCP indicates that a group setting for simultaneous cessation is feasible and highly accepted by participants and course instructors. This is reflected by the finding that both participants and course instructors especially appreciated the analysis of the consumption diary which was accompanied by a long group discussion involving exchanges of experiences and strategies between the participants (Paper 1).

From a health systems perspective, this thesis suggests that treatment should be provided in closer collaboration between those who are primarily responsible for tobacco

interventions and those who are responsible for cannabis use treatment. The need that practitioners from the tobacco and the illegal drug domain break with tradition and work together to provide combined treatments has also been stressed by other authors (Amos et al., 2004; Highet, 2004).

4.4. Implications for Future Research

This thesis suggests several possible avenues for future research in the field of combined interventions for co-smokers of tobacco and cannabis. In the following, several suggestions for future research are given with respect to design and the evaluation of interventions.

Due to the scarcity of evidence in this field of research, much remains to be investigated concerning intervention design. One issue that might especially be important is *treatment intensity*. The finding that some participants reported severe problems during their simultaneous cessation attempt suggests that at least some participants may need more intense treatment. However, multiple behaviour interventions may generally require prolonged treatment. Thus, longer interventions should be developed and evaluated in order to find out whether treatments with longer duration result in increased abstinence rates. Prolonged interventions could support participants not only during the strongest period of withdrawal and early abstinence but also in consolidating their new behaviour and maintaining abstinence. Furthermore, no effects of the web-based interventions evaluated in Paper 3 on substance use were detected. Evidence suggests that the amount of web site exposure and the depth of tailoring web-base interventions is associated with higher rates of tobacco cessation (Hutton et al., 2011). Future research should therefore examine whether more intense motivational web-based interventions result in reduced substance use. However, it should be considered that longer intervention duration is likely to increase the participation threshold. The findings of the preliminary study indicated that co-smokers' readiness to participate in a simultaneous cessation intervention might be only modest. As a consequence, the ISCP was

designed as a comparatively brief intervention, consisting of five sessions. After the first implementation phase, however, the course instructors and participants suggested to extend the treatment duration. Given that recruitment went without any problems during the first implementation phase, the course contents were then redistributed over six instead of five sessions. Although this might have increased the participation threshold, three out of the four courses conducted during the second implementation phase were still well utilised (Paper 1). Whether a treatment with even more sessions would still attract enough participants is not yet clear. Future research should try to determine what treatment intensity optimizes treatment effects on substance use behaviour without considerably lowering participation rate.

A further issue that needs to be addressed is the *treatment setting*. The ISCP presented in this thesis has been carried out in a group setting whilst the only other combined tobacco and cannabis treatment was conducted as an individual treatment (Hill et al., 2013). It would be interesting to examine benefits of the group setting, for instance by including group-level variables in the analyses. However, sample sizes that go beyond the sample size of the feasibility study (77 participants) will then be needed.

Furthermore, several questions regarding *goal setting* should be investigated. While the ISCP reported in Paper 3 had an abstinence goal for both substances and scheduled simultaneous cessation of both substances on a common quit date, other kinds of treatment goals and cessation sequences need to be examined. Although there is emerging evidence indicating that simultaneous cessation may predict better outcomes (Agrawal et al., 2012), several combinations of abstinence and reduction goals for tobacco and cannabis use are possible and may be worth a systematic evaluation. Furthermore, participants probably have their own goals that may not correspond to the official treatment goals and that may also be subject to changes over the treatment period. However, these individual goals are very likely to influence treatment success. For instance, a study that analysed the influence of personal goals on cannabis treatment outcomes revealed that participants were more likely to achieve

outcomes consistent with their personal goals (Lozano, Stephens, & Roffman, 2006). That is, participants with an abstinence goal were more likely to have abstinent outcomes rather than moderated use, and those with a moderation goal were more likely to have moderate outcomes rather than abstinence.

There is also a clear need for more knowledge on how to best *sequence* tobacco and cannabis cessation in combined treatment. Thus it should be analysed whether simultaneous or sequential cessation is more beneficial. Regarding sequential cessation several alternatives are possible, depending on the substance that is stopped first and the delay after which the second is stopped. Probably there is no common rule and participants' individual situation and preferences should be taken into account to find the best procedure. For instance, the sequence could be determined depending on the severity of use or on the readiness to quit each substance (J. J. Prochaska, Spring, & Nigg, 2008). Several studies that analysed tobacco cessation interventions integrated in the treatment of other substance use addressed this issue (e.g. Dunn et al., 2009; Mueller et al., 2012; Nieva et al., 2010). At least for alcohol treatment, the findings indicate that delayed tobacco cessation may be more beneficial regarding alcohol consumption patterns at follow-up whereas tobacco smoking outcomes did not differ depending on the time of intervention delivery (Joseph, Willenbring, Nugent, & Nelson, 2004). Furthermore, studies of interventions for multiple health behaviour change indicated that stopping one substance successfully improves self-efficacy to also abstain from the other substance, arguing for sequential cessation (Noar, Chabot, & Zimmerman, 2008). However, due to the particular relationship between tobacco and cannabis use, findings of smoking cessation interventions that are combined with behaviour other than cannabis use may not be transferable. It also has to be considered that individualisation of the cessation procedure in group therapy setting may have detrimental effects on group dynamics. At least, some participants of the focus-group discussions of the preliminary study preferred a common goal (Paper 1).

Given the high prevalence of co-use among adolescents (Gmel, Kuendig, et al., 2013) and the increasing demand for treatment of cannabis use (European Monitoring Centre for Drugs and Drug Addiction, 2012), another important step would be to develop appropriate dual-interventions for co-smokers of this age.

This thesis also suggests several methodological aspects that should be considered in future research when dual-interventions are evaluated. Now that first findings support the feasibility of dual-interventions for co-smokers (Paper 2, Paper 3, Hill et al., 2013), effectiveness of this approach has to evaluated by conducting *randomized controlled trials*. These could compare dual-cessation interventions with single-cessation interventions and control-groups.

A further relevant issue of intervention evaluation is the development of appropriate *methods to assess and evaluate co-use* of tobacco and cannabis. As discussed in section 4.2, tobacco use and cannabis use are difficult to disentangle because cannabis is mostly co-administered with tobacco. Furthermore, since verification of cannabis-abstinence cannot yet be done in a valid way when using saliva samples (D. Lee & Huestis, 2013), cannabis-abstinence cannot be objectively verified in studies that apply postal data collection. Besides these problems, a general question arises in studies on interventions that target several behaviours simultaneously: How is intervention success best defined and measured? J. J. Prochaska, Velicer, Nigg, and Prochaska (2008) discuss several methods: a) reporting all changes in the individual behaviours separately; b) creating a combined statistical index of overall behaviour change by standardizing scores across the different behaviours; c) using a behavioural index that reflects the number of behaviours for which an individual has reached the criterion of success; d) calculating an overall factor that reflects the impact of the intervention (depending on intervention efficacy and participation); and e) using an overarching outcome measure (e.g. quality of life or cost outcomes). All methods have limitations, e.g. some require a consensus regarding the definition of success criteria [c)] or

large impact [d)] while the combined statistical index [b)] is difficult to interpret and an overarching outcome [e)] may be less sensitive to change. Reporting change in each behaviour separately [a)] increases the chance of a type I error and does not provide an indication of the overall impact of the intervention (J. J. Prochaska, Velicer, et al., 2008). Future research needs to find a consensus on how determine the overall effect of dual interventions for tobacco and cannabis use. Additionally, the changes in the individual behaviours should be reported separately to allow for comparisons with single-interventions.

Furthermore, studies with *longer follow-up period*s should be conducted in order to examine potential long-term benefits of the dual-treatment of tobacco and cannabis.

As summarized in section 2.1.4, evidence regarding differential effectiveness of single-interventions for co-smokers compared to users of only one substance is still scarce and inconsistent (Peters et al., 2012). Thus, *future single-treatment studies* should consequently assess both tobacco and cannabis use among their participants and analyse whether co-smokers profit comparatively less from these interventions. Of course, accounting for correlates of co-smoking that could confound the analysis, such as more severe use at baseline, is also relevant.

Finally, future research should *develop and test theories* that explain the process of dual-cessation. Understanding the underlying processes could contribute substantially to the optimization of dual-interventions for co-smokers. Traditional health behaviour theories such as the Transtheoretical Model of behaviour change (TTM; J. O. Prochaska, DiClemente, Velicer, Ginpil, & Norcross, 1985), the Precaution Adoption Process Model (PAPM, Weinstein & Sandman, 2002), and the Theory of Planned Behaviour (TBP, Ajzen, 1991) try to explain health behaviour and health behaviour change. Moreover, they are often used to plan and evaluate health behaviour interventions. In substance use research, particularly the TTM is often applied despite considerable criticism (West, 2005). However, none of these theories does directly address multiple health behaviour change (Prochaska et al., 2008) and

Noar and colleagues denounce “a dearth of theorizing in the area of multiple behaviour change” (Noar et al., 2008, p. 275).

4.5. Final Conclusions

This thesis contributes to the growing body of literature on co-use of tobacco and cannabis by focusing on interventions tailored to co-smokers. The presented findings indicate that the target group of co-smokers successfully uses the group cessation intervention that is tailored to them. Furthermore, simultaneous treatment of tobacco and cannabis use is feasible, at least within the ISCP that has been evaluated here. However, the evaluation of both the web-based interventions and the group cessation intervention also indicates that addressing tobacco and cannabis simultaneously is complex and may require more intensive interventions. This may be especially true when sustained dual-abstinence is the main goal.

Research on interventions for co-smokers is in its infancy. The ISCP evaluated in this thesis is only the second dual-intervention for co-smokers and it is the first to analyse dual-cessation within a group setting. Furthermore, no other studies analysing web-based interventions for co-smokers exist so far. Thus, future studies should try to replicate the findings and to gain knowledge about mechanisms that underlie simultaneous cessation in order to develop interventions that support co-smokers in the best possible way. Conducting randomized controlled trials to evaluate the efficacy of dual interventions for co-smokers would be an important first step.

PAPER 1. Development of an Integrative Cessation Program for Co-Smokers of Cigarettes and Cannabis: Demand Analysis, Program Description, and Acceptability Study

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Abstract

Background. Tobacco and cannabis use are strongly interrelated, but current national and international cessation programs typically focus on one substance, and address the other substance either only marginally or not at all. This study aimed to identify the demand for, and describe the development and content of, the first integrative group cessation program for co-smokers of cigarettes and cannabis.

Methods. First, a preliminary study using expert interviews, user focus groups with (ex-)smokers, and an online survey was conducted to investigate the demand for, and potential content of, an integrative smoking cessation program (ISCP) for tobacco and cannabis co-smokers. This study revealed that both experts and co-smokers considered an ISCP to be useful but expected only modest levels of readiness for participation.

Based on the findings of the preliminary study, an interdisciplinary expert team developed a course concept and a recruitment strategy. The developed group cessation program is based on current treatment techniques (such as motivational interviewing, cognitive behavioural therapy, and self-control training) and structured into six course sessions.

The program was evaluated regarding its acceptability among participants and course instructors.

Results. Both the participants and course instructors evaluated the course positively.

Participants and instructors especially appreciated the group discussions and the modules that were aimed at developing personal strategies that could be applied during simultaneous cessation of tobacco and cannabis, such as dealing with craving, withdrawal, and high-risk situations.

Conclusions. There is a clear demand for a double cessation program for co-users of cigarettes and cannabis, and the first group cessation program tailored for these users has been developed and evaluated for acceptability. In the near future, the feasibility of the program will be evaluated.

Background

Tobacco and cannabis are interrelated in a unique, multi-dimensional manner, with some connecting mechanisms that are distinct from the co-use of drugs in general (Agrawal et al., 2012). Two of them are the shared route of administration (i.e. both substances are smoked) and co-administration ("mulling", i.e. adding tobacco to cannabis joints, or blunts, i.e. rolling cannabis in cigar paper). Mulling is the most common way of using cannabis in Europe (Bélanger et al., 2011). Epidemiological data show that tobacco smoking is more prevalent among those who consume cannabis compared to the total population. In a study in the United States, 74% of the marijuana users smoked cigarettes compared to 29% of the nonusers (Richter et al., 2005). On the other hand, cannabis use is more common among tobacco smokers than among tobacco abstainers. In the National Survey on Drug Use and Health (NSDUH) in the United States, the 30 days prevalence of cannabis use was 36% among tobacco smokers compared to 11% among non-smokers (Substance Abuse and Mental Health Services Administration, 2013). In a general population survey on tobacco use in Switzerland, cannabis use during the 12 months before the survey was reported by 28% of the adolescents who smoked tobacco daily compared to 9% and 2% of the adolescents who were ex- and never-smokers, respectively (Radtke et al., 2011).

Investigations examining the initiation of use, the transition to regular use, and the cessation of tobacco and cannabis use exemplify this interrelation. Tobacco use can act as a gateway to cannabis use (Bentler, Newcomb, & Zimmerman, 2002), but the reverse, i.e. cannabis use acting as a gateway to tobacco use, has also been observed (Patton et al., 2005; Tullis et al., 2003). Additionally, the probability of a transition from occasional to regular tobacco smoking and nicotine dependence is higher in smokers who also use cannabis (Agrawal, Madden, et al., 2008; Patton et al., 2005). Similarly, (adolescent) cannabis users who also smoke tobacco seem to be at higher risk for regular cannabis use and cannabis dependence in young adulthood compared with cannabis-only users (Swift et al., 2008).

Regarding the cessation of tobacco use, longitudinal observational studies have demonstrated that tobacco smokers who also consumed cannabis made fewer attempts to quit using tobacco (Ford et al., 2002) and were less likely to successfully quit using tobacco compared with tobacco-only smokers (Abrantes et al., 2009). Furthermore, cessation programs that exclusively address tobacco consumption appear to be less effective for individuals who also consume cannabis (Gourlay et al., 1994; Moore & Budney, 2001). A balancing effect is one problem that co-smokers may be confronted with when wanting to stop using only one of the substances. It has been shown that the cessation of one substance often co-occurs with an increased use of the other substance (Akré et al., 2010; Amos et al., 2004; Copersino et al., 2006). These findings highlight the importance of accounting for concurrent tobacco and cannabis use when planning and evaluating interventions.

Despite this evidence, current cessation programs typically focus on one substance while only addressing the other substance either marginally or not at all. To our knowledge, no integrative smoking cessation program (ISCP) targeting co-smokers of cigarettes and cannabis in a group setting has been designed.

However, results of concurrent treatments of tobacco and alcohol dependence (Mueller et al., 2012; Nieva et al., 2010) and tobacco and illicit substance use (e.g. opiates; (Dunn et

al., 2009)) have been published. Additionally, some brief interventions targeting multiple substance use have shown promising results (Gmel, Gaume, Bertholet, Flückiger, & Daeppen, 2013; McCambridge & Strang, 2003, 2004). These findings demonstrate that it is feasible to combine a tobacco cessation intervention with an intervention that targets a second substance. Compared with single interventions, double interventions do not necessarily overstrain participants and reduce abstinence rates; instead, they generate putatively better outcomes with regard to one or both targeted behaviours (S. M. Hall & Prochaska, 2009; J. J. Prochaska, 2010).

The separate treatment histories surrounding tobacco and cannabis may be explained by the different legal statuses of the two substances that are often the subject of political discourse and election campaigns. In Switzerland for example, tobacco is categorised as a licit substance, while cannabis is an illicit drug. The divisions of the Swiss government that deal with these substances are both organisationally and financially separated from each other and, currently, so is the funding for prevention programs and research projects. Another explanation for the lack of combined treatment for tobacco and cannabis use may be the historical development of treatment and prevention systems in many industrialised countries. Treatment of cannabis dependence and co-occurring mental health problems is provided by the psychiatric systems of many countries. In contrast, tobacco cessation is possible without the involvement of psychiatrists and is part of the more general public health systems (S. M. Hall & Prochaska, 2009; J. J. Prochaska, 2010) that typically involve general health supply services. In Switzerland, health insurance coverage differs between the substances; while cannabis treatment in psychiatric services is covered by basic health insurance, smokers themselves are required to pay for nicotine replacement therapy and courses for tobacco cessation.

In recent reviews, researchers have stressed the need to develop and evaluate combined interventions for tobacco and cannabis users (Agrawal et al., 2012; Peters et al., 2012; Ramo

et al., 2012). Agrawal and colleagues found evidence that dual abstinence may predict better cessation outcomes and therefore suggested developing out-patient treatment models (Agrawal et al., 2012).

The aim of the current study was to develop an ISCP. This process was accomplished in three steps, which will be explicated in this report. First, a preliminary study clarified whether there was a demand for an ISCP. Second, after having identified the demand, explicit information regarding co-smokers' attitudes towards tobacco and cannabis and the association between both substances was collected for use when developing an ISCP. Moreover, co-smokers' relevant experiences regarding quitting one or both substances simultaneously were collected. Third, based on the information gained during the second step, an ISCP was developed tailored to co-smokers of cigarettes and cannabis. This program incorporates the established therapeutic principles and strategies of former tobacco and cannabis cessation programs and takes into account reasonable concepts and ideas from the ongoing discussion about the mechanisms underlying the co-use of tobacco and cannabis and potential dependency problems.

Methods

Preliminary Study and Demand Analysis

The perception of and the need for an ISCP were explored with semi-structured qualitative interviews with addiction experts, qualitative age-specific user focus groups, and a quantitative online survey designed for current and former co-smokers. Qualitative data were analysed according to the coding procedures of Grounded Theory (Strauss & Corbin, 1990). Quantitative data were examined with descriptive statistics and logistic regression analyses, which were conducted to identify predictors of readiness to simultaneously quit cigarettes and cannabis. First, bivariate logistic regression analyses were used to identify potential predictors. These predictors were then entered into one model. Next, non-significant variables

($p \geq .05$) were removed successively from the multivariate model. The resulting model was verified by separately adding the excluded variables to the model to account for suppressor effects. Only significant predictors ($p < .05$) were retained in the final model. In these analyses, only the respondents currently smoking cigarettes and using cannabis were included. All quantitative analyses were conducted using PASW Statistics Version 18 and 20 (SPSS Inc., Chicago, IL, USA).

Expert interviews

Twelve addiction experts participated in the semi-structured interviews about the relationship between tobacco and cannabis use and the demand for and possible design of an ISCP. These addiction experts worked in research or were practicing psychotherapy, medicine, prevention, or epidemiology. The majority were known local experts in tobacco and/or cannabis use. The experts were reimbursed with 180 Swiss Francs (corresponding to about 167 US dollars in February 2010 when the interviews were conducted). Most of the experts emphasised a substantial relationship between tobacco and cannabis use that can cause problems, especially in the context of cessation attempts. For example, some experts observed that individuals who consumed both tobacco and cannabis increased their use of one substance when attempting to quit the other, which could lead to elevated risk of relapse. Quitting both substances simultaneously might prevent this balancing effect. Thus, the experts perceived a clear demand for an ISCP. Despite this demand, the experts assumed that few co-smokers would be ready to stop their tobacco and cannabis use simultaneously because smokers often perceived quitting tobacco use as a "loss" and probably would not be ready to additionally "give up" cannabis use.

Regarding the design of an ISCP, the experts favoured a group setting and suggested incorporating methods from cannabis treatment manuals into an established tobacco cessation program. The experts believed that integrating an additional substance into a tobacco cessation program would enhance its complexity (e.g. they expected a relatively high rate of

participants with psychiatric comorbidities such as depression). Thus, an ISCP should offer comprehensive medical, psychiatric, and psychotherapeutic support for participants, on-demand additional single treatment sessions, and specific training for the course instructors that would aid in addressing the complexities and potential problems of double cessation.

The experts differed in their opinions about the appropriate age range of the participants. However, some experts suggested that co-smokers aged 25 years and above should be targeted because the experts expected a higher level of readiness to participate in an ISCP among this age group compared with younger co-smokers. This reasoning was based on the common assumption that cannabis use during adolescence is transient and thus less problematic and on the fact that family planning usually becomes more relevant at the age of 25 years. Two experts suggested separating groups by gender.

Focus groups with former and current co-smokers

The focus group discussions were conducted to gain in-depth information concerning users' problems, experiences, and methods of coping with the issues that occurred during cessation attempts. Recruitment was organised via counselling facilities, and participants received financial reimbursement for participation. To be included in the focus group discussions, candidate participants had to self-report 1) past or current tobacco dependence, 2) past or current use of cannabis at least several times per week, and 3) at least one attempt to quit cigarette smoking, cannabis use, or both with formal treatment. As an incentive, focus group participants received 100 Swiss Francs in cash (corresponding to about 95 US dollars in April 2010 when the focus groups were conducted).

Similar to the experts, the 14 participants of the focus group discussions (10 adolescents aged 16 to 22 years and four adults aged 27 to 39 years) perceived a strong relationship between tobacco and cannabis use. Many of the participants reported experiences with the aforementioned balancing effect. However, the adolescents in particular demonstrated low willingness to quit cannabis and discussed their negative outcome expectancies concerning

tobacco and cannabis cessation attempts (e.g. weight gain, sleeplessness, and increased alcohol consumption). The participants assumed that the general willingness of co-smokers to quit both substances would be low. However, due to the relationship between tobacco and cannabis use, they considered an ISCP to be useful.

Regarding the ISCP design, participants emphasised the importance of appropriate knowledge transfer concerning the interrelationship of the substances. The participants deemed the differences between potential participants with regard to their motivations to quit, aims, consumption patterns, and life situations to be relevant. Therefore, they suggested that all course participants should form a common goal. Furthermore, focus group participants indicated that there was a strong need for the development of appropriate relaxation and stress reduction methods.

Online survey with former and current co-smokers

Taking into account the information provided by the expert interviews and user focus groups, the online survey included questions concerning smoking behaviour, quitting experiences, and attitudes towards tobacco, cannabis, and an ISCP. Moreover, the online survey investigated the demand for an ISCP, co-smokers' willingness to participate in such a program, and their readiness to quit both substances simultaneously. Former co-smokers were asked to indicate whether they would have been willing to participate in an ISCP and whether they would have been ready to quit tobacco and cannabis simultaneously. Recruitment was achieved through advertisements in internet forums on smoking, cannabis use, and health and via two social media platforms. Lotteries for a city trip, a tablet computer, and book vouchers were used to encourage participation.

The online survey began with 247 respondents who met the inclusion criteria of smoking both tobacco and cannabis either regularly at the time of the survey (current co-users, $n = 109$) or in the past ($n = 138$). Current co-use was defined as daily tobacco use and the use of cannabis during the past seven days before the survey. The survey was completed

by 79.4% (196/247). Data from drop-outs were excluded in an item-wise manner. There were no significant differences between the drop-outs and the completers regarding age ($U = 4908.50$, $p = .84$), sex ($\chi^2(1) = 0.368$, $p = .64$), educational level ($U = 4751.5$, $p = .58$), or smoking frequency (tobacco: $U = 4560.0$, $p = .29$; cannabis: $U = 4616.5$, $p = .40$).

The respondents were between the ages of 14 and 88 years ($M = 28.71$, $SD = 8.46$), and 44.9% (111/247) were female. More than half of the respondents had previously attempted to stop smoking tobacco (74.7%, 183/245) and/or cannabis (51.2%, 124/242) at least once. Of those who had attempted to quit tobacco, 19 respondents (33.3%) increased their cannabis use after their tobacco cessation. More than half (51.6%) of those who had attempted to quit cannabis reported an increase in tobacco use.

Table 1. *Reasons for quitting tobacco and cannabis use among online survey respondents (*n = *219)*

Which have been or could be reasons for you to quit tobacco/cannabis? *Multiple answers possible.*	***n* (%) of respondents who checked each reason for quitting tobacco/cannabis**		**McNemar test**	
	Tobacco	Cannabis	χ^2	*p*
Problems with health	145 (66.2)	102 (46.6)	22.33	< 0.001
Decreasing physical fitness	134 (61.2)	77 (35.2)	40.73	< 0.001
Pregnancy/starting a family	87 (39.7)	73 (33.3)	4.97	0.026
Financial reasons	70 (32.0)	57 (26.0)	2.82	0.093
Non-smoking partner	69 (31.5)	43 (19.6)	14.20	< 0.001
Feeling of being dependent/not free	113 (51.6)	79 (36.1)	13.28	< 0.001
Problems with memory or concentration	37 (16.9)	112 (51.1)	62.94	< 0.001
Problems with motivation or achievement	47 (21.5)	113 (51.6)	52.81	< 0.001
Mental health problems	39 (17.8)	100 (45.7)	53.73	< 0.001
Other	21 (9.6)	32 (14.6)	3.45	0.063

Note. McNemar's χ^2 with continuity correction.

As shown in Table 1, smokers' potential and ex-smokers' actual reasons for quitting differed

significantly according to the substance (tobacco or cannabis). Reasons for quitting tobacco use were related to physical health aspects, whereas the most common reasons for cannabis cessation were problems with memory, concentration, motivation, and achievement. Respondents could also specify further reasons, which were not included in the list. The listed reasons were quite heterogeneous. However, several respondents mentioned the lack of desire to smoke tobacco and/or cannabis as a potential or actual reason to quit. For tobacco use, several respondents listed olfactory or gustatory reasons for quitting, and for cannabis use, some respondents mentioned that they experienced no effects or negative effects after the use of the substance as a reason for quitting.

Table 2 shows attitudes towards the potential negative effects of tobacco and cannabis smoking. Compared to the analogous statements for cannabis smoking, a significantly higher proportion of respondents confirmed the statements concerning the negative effects of tobacco smoking.

Table 2. *Attitudes towards tobacco and cannabis use among online survey respondents of the preliminary study (n = 216)*

Smoking tobacco/cannabis…	**Tobacco**	**Cannabis**	**Wilcoxon signed-rank test**	
	***n* (%)**	***n* (%)**	***z***	***p***
…is harmful to my health	197 (91.2)	114 (52.8)	-8.38	< 0.001
…can cause lung cancer, heart diseases and other serious diseases	190 (88.0)	122 (56.5)	-7.52	< 0.001
…is addictive	185 (85.6)	81 (37.5)	-9.13	< 0.001
…promotes premature skin aging and harms one's appearance	147 (68.1)	75 (34.7)	-8.43	< 0.001

Note. Items could be answered with "I fully agree", "I somewhat agree", "I somewhat disagree", or "I fully disagree", *n* (%) for "I fully agree" responses are displayed.

Half of the respondents (124/247) thought that smoking tobacco and cannabis were

interrelated (33.6% responded “yes probably”, and 16.6% responded “yes”). Furthermore, 67.6% (140/207) of the respondents affirmed the need for an ISCP (22.2% responded “yes”, and 45.5% responded “yes probably”).

However, of those who were currently smoking tobacco and using cannabis only 27.6% (29/105, 95% CI [0.20, 0.37]) stated that they felt ready to quit both substances simultaneously (15.6% responded “yes”, and 11.0% responded “yes probably”), and 41.4% (36/87, 95% CI [.31, .52]) felt ready to participate in an ISCP (10.1% responded “yes”, and 22.9% responded “yes probably”).

Three predictors significantly predicted readiness to quit tobacco and cannabis simultaneously in a logistic regression analysis. Age was positively associated with readiness for simultaneous cessation, $OR = 1.11$, 95% CI [1.03, 1.19], $p = .00$). Furthermore, using cannabis at least once a week predicted a lower likelihood of feeling ready to quit compared with using cannabis less frequently, $OR = 0.12$, 95% CI [0.04, 0.40], $p = .001$. Finally, partial or full agreement with the statement “Cannabis is harmful to my health” increased the likelihood of readiness to quit the substances simultaneously, $OR = 4.13$, 95% CI [1.43, 11.94], $p = .009$.

With regard to the program design, more than 70% (127/179) of the respondents considered an ISCP useful for individuals between 20 and 25 years and more than half of the respondents found it useful for those between 15 and 20 years (101/179) and for those between 25 and 30 years (98/179; multiple answers possible). In general, 69.9% (137/196) of the respondents preferred age-separated but only 14.3% (28/196) preferred sex-separated groups. The majority of the respondents (66.9%, 131/196) also suggested making the groups accessible only to smokers of both substances.

Conceptualisation of the Intervention

Given that both experts and co-smokers considered a therapeutic program for co-smokers as

important and sensible, the development process was continued.

The intervention development proceeded as follows: first, literature was reviewed concerning effective interventions for tobacco and those for cannabis. Based on these findings and the results of the preliminary study, an interdisciplinary expert team was composed of three psychologists, one social education worker, and three psychiatrists developed the group intervention. The team members had experience (and expertise) in research, therapeutic practice (single and group interventions for tobacco, alcohol, and illegal drugs), and/or the development of intervention programs for the treatment of substance abuse. The program development was an incremental and iterative process that provided the team members with multiple opportunities for feedback. The experts met eight times during the seven months before the beginning of the course. During and after the first implementation phase, the experts held two further meetings to adapt the manual for the second implementation phase.

Additionally, a thorough recruitment strategy was designed to reach as many co-smokers as possible and motivate them to participate in the ISCP. The recruitment process was conceptualised as an integral part of the ISCP and acted as an intervention in and of itself. Therefore, this recruitment strategy will be described in detail in the following chapter about the ISCP.

After the first implementation phase, the intervention was slightly refined based on the feedback of the course facilitators, some of whom were also part of the expert team. Given that there were only minor changes (i.e. the addition of a sixth course session that did not add content, as it only redistributed the course contents over six instead of five sessions), in the following chapter not both versions are described but only the adapted, second version.

Description of the Integrative Cessation Program for Co-Smokers of Cigarettes and Cannabis

Recruitment strategy

The recruitment strategy was planned extensively given that both the experts and focus group participants anticipated in the preliminary study that co-smokers would only show modest willingness to quit their tobacco and cannabis use simultaneously and to participate in an ICSP. To reach as many co-smokers as possible, information about the new course was spread via different channels.

First, a website (www.i-cut.ch) consisting of two parts was designed. The first part provided information about the course (i.e. content, structure, and dates) and the possibility to register for an information evening. The second part aimed to enhance co-smokers' motivation to quit simultaneously and participate in the ISCP, primarily by providing information, offering a self-assessment with normative feedback, and using techniques adapted from motivational interviewing (Miller & Rollnick, 2002).

During the next step, a press release was issued. This step occurred only once at the beginning of the study and attracted a great deal of interest, which resulted in several reports in local newspapers and on radio and TV stations. Counselling centres for addiction prevention and treatment, psychiatrists, and health (care) centres in the canton of Zurich and bordering cantons helped spread flyers and leaflets that referred to the website for more information. Additionally, two social media platforms and an advertisement in the online edition of a popular free newspaper were used for online recruitment, also referring to the program website for more information.

The final step involved planning an information evening. Interested co-smokers could attend it without any obligation to participate in the course. The information evening provided the opportunity to ask questions that were answered by the course instructors, who introduced themselves and the course program and presented some background information. As central

issues, they emphasised the association between tobacco and cannabis use and the potential physical harm of cannabis use, which was underestimated by co-smokers in the preliminary study. Additionally, instructors mentioned that co-smokers could participate together with co-smoking friends and partners to start the behavioural change together and support one another.

Course setting

Consistent with the findings from the preliminary study, the expert team considered an outpatient group-setting with 8 to 12 co-users of tobacco (who smoked at least one cigarette per day) and cannabis (who smoked at least once a week) per group as appropriate. The group-setting was preferred due to several general advantages of group therapy, such as cost-effectiveness (fewer treatment personnel are needed) and interpersonal processes (e.g. peer support and peer pressure) (Treatment Center for Substance Abuse & Therapy, 2005). Additionally, in this new field of dual cessation of tobacco and cannabis use, the opportunity of group participants to share cessation experiences and strategies was considered especially important.

Given that the co-smokers in the preliminary study preferred age-specific groups, we set the minimum age for participation in the ISCP at 20 years. Adolescents were excluded from this first version of the intervention for two reasons. First, being younger was associated with a decreased readiness to quit tobacco and cannabis simultaneously among the online survey respondents of the preliminary study. This finding is in line with the assumption of some of the interviewed experts in the preliminary study who expected greater readiness to participate among co-smokers aged 25 years and above. Second, an effective ISCP for adolescents should presumably differ from an ISCP designed for adults; for example, an ISCP for adolescents should account for school and family problems. Thus, the expert team decided to develop a basic program version for adults that could be adapted for adolescents if the basic version proved to be feasible. Separating groups by gender was considered but deemed to be

unfeasible due to the expected low number of co-smokers who were ready for participation. Furthermore, the online survey respondents in the preliminary study clearly preferred age-specificity to gender-specificity.

Two local addiction treatment centres in the Swiss cities of Zurich and Winterthur offered the courses. Each course was guided by two course instructors, at least one of whom had to be a psychiatrist to guarantee the offer of prescription pharmacotherapy to reduce acute withdrawal symptoms or eventual exacerbations of severe psychiatric symptoms. The second instructor had to have experience in treating tobacco or cannabis smokers and could be from a different profession. The members of the expert team either guided the course sessions themselves or trained additional instructors to do so. All instructors received a therapist manual containing instructions for guiding the sessions and the information that was provided to the participants in their workbook (see below).

Course structure, content, and goals

The experts interviewed during the preliminary study recommended using an established tobacco cessation program as the basis for the ISCP and combining it with cannabis-specific elements. We therefore utilised parts of the group tobacco cessation course used by the UK's leading charity for gay men's health (GMFA), which was evaluated by Harding and colleagues (2004) and with which we were familiar, given that we culturally adapted and scientifically evaluated this program for Switzerland. We integrated elements from cannabis interventions that were ongoing under the supervision of members of the expert team. The resulting course was structured into six weekly sessions and one revival meeting that occurred approximately six weeks after the last session (Figure 1). Given anticipated recruitment problems, the expert team chose a small number of sessions to generate a low-threshold intervention. Each of the sessions lasted between 90 and 120 minutes. Additionally, course instructors offered each participant one individual counselling session on request.

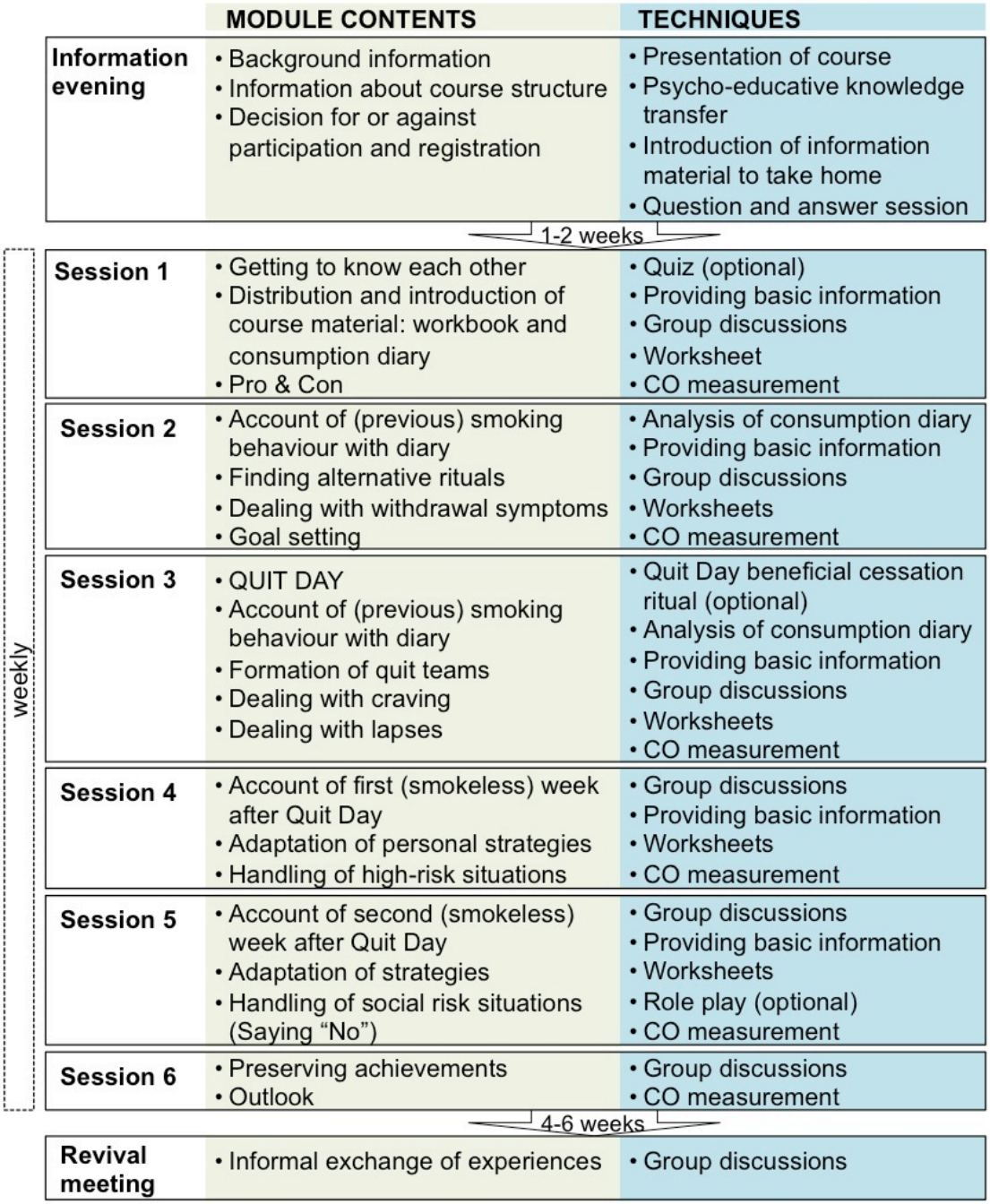

Figure 1. Course structure, content, and techniques of the integrative cessation program for tobacco and cannabis co-smokers.

Subsidiary elements of the course sessions were a smoking diary and workbook which were introduced and distributed to the participants during the first session. The workbook contained background information, an overview of the course structure and content, and work sheets to reflect on personal reasons for cessation and develop and write down personal strategies. The smoking diary was a small notebook that could easily be carried to constantly monitor

consumption and thoughts, feelings, and actions associated with the use of one or both of the substances. The notebook should promote vigilance and self-examination. Furthermore, participants measured their expired carbon monoxide at every session to receive an immediate objective feedback on their therapy progress and for later program evaluation. They could enter their individual values in their notebooks and thereby monitor the changes in the values.

The main goal of the intervention was dual abstinence of tobacco and cannabis. The instructors promoted moderation of tobacco and/or cannabis use, for example, reducing smoking frequency or changing to a less harmful method of administration (e.g. consuming cannabis orally based on medical cannabis use recommendations for severe treatment resistant diseases) only when participants failed to quit several times during the course. This was done to avoid course dropout. Regarding the cessation sequence of tobacco and cannabis, the expert team supported a simultaneous cessation with one fixed quit date (Quit Day), when the participants were required to stop their tobacco and cannabis use, which is in line with Agrawal's suggestions (Agrawal et al., 2012). Before that date, participants could either maintain their normal use of tobacco and cannabis or start to reduce or stop one or both substances. Apart from the importance of having a common goal, i.e. stopping the use of both substances on a fixed quit date (at the latest) to foster group dynamics, this procedure was chosen for several reasons. First, the strong association between tobacco and cannabis use, in that each substance may act as a behavioural cue for the other (Agrawal & Lynskey, 2009a), suggests that using neither substance is likely the easiest manner of quitting. In addition, this strategy has the advantage of experiencing only one withdrawal phase. Withdrawal symptoms may be stronger for the cessation of both substances compared with the symptoms for each substance alone, yet evidence suggests that this difference occurs for only a short duration and varies substantially between individuals (Vandrey et al., 2008). For some quitters, withdrawal during dual abstinence may even be less severe than withdrawal from each substance individually (Vandrey et al., 2008).

Therapeutic principles

The course was primarily based on principles of motivational interviewing (Miller & Rollnick, 2002), self-control practices (Sobell & Sobell, 1993), the relapse-prevention model (Marlatt & Donovan, 2005), and methods used in cognitive behavioural therapy that have been shown to be effective in the cessation of tobacco (Health et al., 2008) and cannabis (Budney et al., 2007; Sobell, Sobell, Wagner, Agrawal, & Ellingstad, 2006; Stephens et al., 2006).

Although most of these principles and techniques were applied throughout the whole duration of the course, the emphasis on the application of each principle differed according to the Transtheoretical Model of Behaviour Change (James O. Prochaska & DiClemente, 1983). Consequently, motivational enhancement strategies predominated in the early sessions of the intervention to address participants' ambivalence about quitting and strengthen their motivation to change. In the following sessions, self-control practices were highlighted, such as an analysis of one's own smoking behaviour with the help of the smoking diary. After the Quit Day, relapse prevention was the focus; relapse prevention focused on the development of personal strategies to avoid or cope with tobacco and cannabis use triggers.

Additionally, participants were encouraged to use medications that are typically used as first-line medications to increase long-term tobacco abstinence (Health et al., 2008). As some negative outcomes have been observed in bupropion studies with cannabis users (Haney et al., 2001; Neumann, Livak, & Paul, 2004), course instructors recommended varenicline and nicotine replacement therapy. Instructors provided information about these medications during the informational evening, handed out leaflets that participants could take home, and indicated the corresponding information in the workbook that every participant received at the start of the course.

The intervention sessions that followed the information evening occurred in a group course setting. A meaningful part of every session was the group discussion. In these

discussions, the participants could share experiences and problems, and support was provided both among the participants and from the instructors to the participants (i.e. intra-treatment support). Confidentiality was ensured, and instructors placed great value on providing an open, non-judgemental atmosphere. Additionally, the instructors promoted the formation of small quit teams, i.e. subgroups of two or three participants who supported each other, especially between the course sessions, such as during episodes of strong craving. Engagement in a Quit Team was optional and the formation and organization of the Quit Teams was not guided by the course instructors.

Acceptability Study of the Integrative Cessation Program

We investigated the acceptability of the intervention among the participants and course instructors. Further analyses of smoking-related outcomes and utilisation will be conducted with the follow-up data in the near future.

Sampling and recruitment

Course participants were recruited with the above-mentioned methods. To be included in the intervention, participants had to use cannabis at least weekly, smoke tobacco (in addition to any tobacco used in joints) daily, be at least 18 years old, and be German literate. Participants were not reimbursed, but participation was free, which may have been attractive because, in Switzerland, tobacco cessation programmes usually require payment from the participants themselves.

Recruitment of course instructors began within the expert team that developed the intervention. As mentioned above, some experts also acted as course instructors. The experts also trained co-workers from their institutions to guide the courses.

Measurements and analyses

At the end of treatment, participants completed questionnaires that they received either at the end of the last session or by mail if they missed the last session. The questionnaire contained a

set of items that measured the participants' opinions toward the intervention in general and toward several components of the intervention. The instruction for the general items began as follows: "How would you evaluate the course regarding…". The instruction for the course component items began as follows: "How helpful were the following components for you?" All items were rated on a scale from 0 to 5, and higher values indicated more positive evaluations.

The course instructors received an analogous evaluation form after they had conducted the last course and indicated to what extent the course components were helpful to the participants.

In addition to descriptive statistics, the ratings for the general items were compared between participants of the first (five course sessions) and second implementation phases (six course sessions) using Mann-Whitney U tests. This comparison was not applied to the specific course components because their contents did not differ between the two phases.

Ethical Approval

This intervention study was performed in compliance with the Declaration of Helsinki and was reviewed by the Ethics Committee of the Canton of Zurich, which did not declare any objections (KEK-StV-Nr.23/11). Participants signed an informed consent form prior to the first group therapy session.

Results

Sample Characteristics

Over nine months, a total of 77 co-smokers participated in seven groups with six to 13 participants each. Of these participants, 59 (76.6%) answered at least one item of the course evaluation. Of these 59, 31 participated during the first and 28 during the second implementation phase. The majority of the respondents (71.2%) were male, their mean age

was $M = 34.0$ ($SD = 8.1$) years, and most (84.7%) were Swiss. Regarding educational attainment, 33.9% had a university degree, 51.5% had completed secondary education (the majority of these participants had finished an apprenticeship), 5.1% had finished primary school, 3.4% had no degree, 3.4% had a degree not listed, and 1.7% did not answer this question. In addition to the participants, all course instructors ($N = 8$, 3 females) completed the evaluation form.

Participants' and Course Instructors' Evaluations of the Intervention

Overall, the course was rated positively by the participants ($M = 3.9$, $SD = 1.1$) and course instructors ($M = 4.3$, $SD = 0.5$). Regarding its comprehensibility, participants and course instructors evaluated the course very positively ($M = 4.5$, $SD = 1.0$ and $M = 4.3$, $SD = 0.7$, respectively). The ratings of the courses' atmosphere were comparatively high (participants: $M = 4.3$, $SD = 1.1$; course instructors: $M = 4.5$, $SD = 0.5$). Participants rated the opportunity to openly discuss illegal issues particularly high ($M = 4.6$, $SD = 1.0$), and the course instructors also provided high ratings on this measure ($M = 4.3$, $SD = 0.7$). As displayed in Table 3, compared to the ratings of the phase 1 participants, the ratings of the phase 2 participants tended to be higher across all general items. These differences were statistically significant for the overall evaluation and the evaluation of comprehensibility.

Table 3. *General course evaluations from the participants of implementation phases 1 (*n = *31) and 2 (*n = *28)*

How do you evaluate the course…	**Phase 1 participants**	**Phase 2 participants**	**Mann–Whitney-*U* test**	
	M (SD)	*M (SD)*	*U*	*p*
…overall	3.6 (1.1)	4.1 (1.0)	306.0	.041
…regarding its comprehensibility	4.2 (1.2)	4.8 (0.5)	258.5	.018
…regarding the atmosphere	4.1 (1.2)	4.5 (0.9)	290.5	.100
…regarding the possibility to openly discuss illegal issues	4.4 (1.1)	4.8 (0.7)	302.5	.100

Note. Items were answered on a scale ranging from 0 (not good at all) to 5 (very good).

Table 4. *Course participants' (*n = *56) and course instructors' (*n = *8) evaluations of the course components*

How helpful were the following components for you/for the participants?	**Participants** *M (SD)*	**Course instructors** *M (SD)*
Information evening	3.6 (1.5)	4.3 (1.0)
Quiz	3.3 (1.4)	4.0 (1.3)
Pro & Con	3.5 (1.4)	4.0 (0.8)
Analysis of consumption diary/group discussion	4.1 (1.1)	4.3 (0.9)
Finding alternative rituals	3.8 (1.3)	4.4 (0.5)
Dealing with withdrawal symptoms	3.8 (1.4)	4.4 (0.5)
Goal setting	3.6 (1.4)	4.0 (0.8)
Handling of high-risk situations	3.8 (1.2)	4.3 (0.5)
Dealing with craving	3.7 (1.2)	4.6 (0.5)
Adaptation of personal strategies	3.4 (1.3)	4.0 (0.9)
Dealing with lapses	3.7 (1.3)	4.1 (0.6)
Handling of social risk situations (Saying "No")	3.2 (1.4)	3.6 (0.9)
Preserving achievements	3.4 (1.3)	3.6 (0.9)
Participants' workbook	3.2 (1.4)	3.6 (1.0)
Consumption diary	3.3 (1.4)	3.4 (0.9)
Carbon mononxide measurement	3.7 (1.5)	4.5 (0.8)
Quit Team[1]	2.4 (1.7)	3.3 (1.0)

Note. Items were answered on a scale ranging from 0 (not helpful at all) to 5 (very helpful). [1]Only the ratings of the 38 participants who were member of a Quit Team are displayed.

Table 4 summarises the participants' and course instructors' evaluations of the different course components. Participants particularly appreciated the analysis of the consumption diary ($M = 4.1$, $SD = 1.1$), which was usually accompanied by an extensive group discussion involving exchanges of experiences between the participants. With the exception of "handling of social risk situations", participants and course instructors provided high ratings of all the modules that aimed at developing concrete, personal strategies for handling problems that can occur during smoking cessation. Course instructors also considered the carbon monoxide measurement as helpful for the participants. Of all the course components, the Quit Teams which were an optional element received the lowest ratings from both the course instructors ($M = 3.3$, $SD = 1.0$) and the 38 participants who indicated that they have been a member of

such a Quit Team (M = 2.4, SD = 1.7).

Discussion

This study describes the development and content of the first integrative group cessation program for co-smokers of tobacco and cannabis. The program was developed after a preliminary study revealed that both experts and co-smokers of cigarettes and cannabis demanded combined interventions to address simultaneous tobacco and cannabis cessation. This result is consistent with previous theoretical discussions (Agrawal et al., 2012; Peters et al., 2012; Ramo et al., 2012).

During the preliminary study, experts stressed the multi-dimensional relationship between tobacco and cannabis use that is particularly evident during cessation attempts. Many consumers reported experiencing the balancing effect mentioned by the experts (i.e. the increased use of the other substance after quitting the first substance). However, among the queried co-smokers, there was only a modest level of readiness to quit tobacco and cannabis simultaneously and of readiness to participate in an ISCP that addressed both substances at the same time. Many co-smokers were not aware of the relationship between tobacco and cannabis use or the harmful physical health consequences of smoking cannabis. This lack of awareness might explain the modest level of readiness to quit simultaneously. To overcome this lack of awareness and knowledge, the interdisciplinary expert team developed a participant recruitment strategy that was an integral part of the ISCP.

The recruitment for the courses was a success because 77 participants were recruited, and seven courses were accomplished within a relatively short time frame of nine months. This success may be attributable to two factors. First, course participation was free of charge because the ISCP was still in development. In Switzerland, participants are usually required to pay for their own participation in tobacco cessation programs. Thus, participation rates may change when the program cannot be offered free of cost. Second, after the press release and a

report that appeared in a common free commuter newspaper at the beginning of the first implementation phase, participation rates for the information evening and the course itself were especially high. Because this strategy cannot be applied regularly, it is necessary to switch to appropriate alternatives in the future. In Switzerland, these alternatives could include regular advertisements in the two most common commuter newspapers, which reach a large part of the population.

According to their evaluations of the course, both the participants and the course instructors found the ISCP highly acceptable. Because the items measuring the general acceptance of the course were rated more positively by the participants of the second implementation phase, a course length of six, rather than five, sessions may be more appropriate. The finding that participants especially appreciated the group discussions indicates that group settings are appropriate for targeting co-smokers of tobacco and cannabis. Furthermore, participants and course instructors valued those course modules that aimed at developing strategies which can be applied when quitting tobacco and cannabis use. Additionally, the course instructors considered the carbon monoxide measurements to be helpful. Thus, these measurements should remain part of the intervention when the scientific evaluation is completed and biochemical validation is not needed any longer.

The Quit Teams were the least appreciated course element and only two thirds of the participants engaged in a Quit Team. Possibly the participants felt no need of this optional buddy support system because the group setting provided sufficient social support. Thus, exclusion of the element of Quit Teams could be considered for a future version of the program. This conclusion is supported by two studies which show that buddy systems provide an additional benefit in an individual smoking cessation setting (West, 2005) but not in a group setting (May, West, Hajek, McEwen, & McRobbie, 2006).

The ISCP developed in this study combines two substances in one cessation program and connects professionals from general health provider services and psychiatric services.

Consequently, the professionals from these services will learn and potentially benefit from their complementary knowledge and experiences. However, beyond this intervention, policy makers should be sensitive to the issue of tobacco and cannabis co-use. Furthermore, the treatment of co-use should be implemented in the health care system and should be covered by existing basic health insurance. The public health approach of Screening, Brief Intervention, and Referral to Treatment (SBIRT) could be applied to the co-use of tobacco and cannabis. Thus, screening for tobacco use in primary care settings could be extended to include screening for co-smoking. Depending on the severity of co-smoking and the willingness to quit, practitioners could then provide information and advice and refer co-smokers to targeted interventions such as the one presented here. Proactive strategies like this may be capable of reaching a broad range of co-smokers and prevent the intake problems that the ISCP might face when it will be conducted without the media interest that surrounded its first implementation. Historical precedents, such as ignoring cannabis in tobacco cessation programs and vice-versa and the use of cigarettes as reinforcers in psychiatry (S. M. Hall & Prochaska, 2009; J. J. Prochaska, 2010), will hopefully become issues of the past.

However, the co-use of tobacco and cannabis should not only be addressed in treatment but also in prevention. According to the findings of our preliminary study, there is a lack of knowledge about the relationship between tobacco and cannabis among co-smokers. It is likely that smokers who only use tobacco or cannabis are not aware of this issue, and it is possible that increased awareness would help to prevent the initiation of the use of the second substance among these smokers. Thus, information about the problems associated with co-smoking should be spread, especially among adolescents and young adults.

One limitation of this study is that the online survey of former and active co-smokers was conducted using a convenience sample with a wide age range, those data are based on self-reports and retrospective cessation attempt reports. Furthermore, it is difficult to disentangle the reasons for the differences in the general evaluations of the course between

the first and the second implementation phases. Course length may be one reason, but other factors, such as the number of participants in the courses and the identities of the course instructors, also varied between implementation phases.

Currently, we are conducting a thorough feasibility study on the ISCP and expect to have the results of the follow-up data in the autumn of 2013. More details on this feasibility study are provided in the study's entry at Current Controlled Trials (ISRCTN15248397).

Conclusions

The proposed intervention for co-smokers of tobacco and cannabis is important because it is the first group cessation program targeting these two interrelated substances simultaneously. The developed ISCP integrates the opinions of both users and experts, established therapeutic principles, and the strategies of former tobacco and cannabis cessation programs. This intervention also takes into account reasonable concepts and ideas that have emerged from on-going discussions about the underlying mechanisms and relationships between cannabis and tobacco use, such as the common route of administration (Agrawal et al., 2012). To prevent one substance from acting as a behavioural cue for the other (Agrawal & Lynskey, 2009a), participants are expected to quit both substances simultaneously. Preliminary results show that the developed ISCP was well accepted among the participants and the course instructors. The group discussions and the development of personal strategies for the dual cessation of tobacco and cannabis use were particularly appreciated. These promising results also underline the high acceptance of the ISCP among the co-smokers, who, for the first time, had access to a group intervention especially targeted to them.

In the near future, the presented ISCP will be evaluated for feasibility and initial efficacy.

PAPER 2. Feasibility, Safety, and Initial Effectiveness of an Integrative Group Cessation Intervention for Co-Smokers of Tobacco and Cannabis

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Abstract

Aims. To evaluate the feasibility and initial effectiveness of an integrative group cessation program for co-smokers of tobacco and cannabis

Design. Feasibility study using a within-participants design with pre-, post-, and 6-month follow-up assessments

Setting. Two addiction treatment centres in Zurich and Winterthur, Switzerland

Participants. A total of 77 adults who used cannabis at least once per week and tobacco (i.e. cigarettes or similar products) at least once per day

Measurements. The primary outcomes included cigarette-use frequency, cannabis-use frequency, and dual-abstinence at the 6-month follow-up assessment.

Findings. 41.5% and 23.4% of the participants reported abstinence from cigarettes, cannabis, or both at the end-of-treatment and the 6-month follow-up assessment. The separate, self-reported abstinence rates for cigarettes and cannabis were 32.5% and 23.4% (end-of-treatment assessment) and 10.4% and 19.5% (follow-up). Cotinine-validated dual-abstinence was achieved by 13.0% (end-of-treatment) and 5.2% (follow-up). Generalised estimating equations revealed that tobacco-use frequency ($p = .001$) and cannabis-use frequency ($p < .001$) decreased significantly over the study period. Furthermore, all secondary outcomes improved significantly over time (problem drinking: $p = .003$; cigarette dependence, cannabis use disorder symptoms, depression, anxiety: all $p < .001$). Among participants who quit only one substance we did not find evidence of a compensatory increase in the use of the other substance. The treatment retention was 62.3%, and participant satisfaction was high. Only

three people discontinued their participation due to severe problems that emerged during the treatment.

Conclusion. The evaluated group cessation program for co-smokers of tobacco and cannabis is safe and feasible.

Introduction

Tobacco smoking is among the three leading risk factors for the global disease burden (Lim et al., 2012). Cannabis use is associated with a range of problems including those related to mental and physical health, cognition, and educational outcomes (Caldeira et al., 2012; W. Hall & Degenhardt, 2009). Both substances are often used concurrently. Tobacco smokers are more likely to use cannabis compared with non-smokers (SAMHSA, n.d.) and vice versa (Richter et al., 2005). The mechanisms linking these two substances most likely extend beyond a shared vulnerability and the co-use of substances in general (Agrawal & Lynskey, 2009a). Among these connecting mechanisms are the shared route of administration (i.e. both substances are typically smoked) and co-administration (e.g. tobacco is added to cannabis joints in a process known as "mulling") (Agrawal et al., 2012). In Switzerland, 90% of cannabis users smoke joints mixed with tobacco (Baggio et al., 2013).

This strong relationship between tobacco and cannabis use is also relevant in the context of cessation. Epidemiological evidence shows that co-smokers make fewer attempts at quitting tobacco use compared with tobacco-only smokers (Ford et al., 2002) and are less successful at quitting (Abrantes et al., 2009). Compared with tobacco-only smokers, co-smokers have poorer outcomes when participating in tobacco-cessation interventions (Gourlay et al., 1994). Correspondingly, cannabis-dependence treatments are less effective among individuals who also smoke tobacco (de Dios et al., 2009; Moore & Budney, 2001). Moreover, a laboratory study of non-treatment-seeking marijuana users revealed that co-smokers of cigarettes were more likely to relapse after a phase of cannabis abstinence

compared with non-cigarette smokers (Haney et al., 2013). Smoking cigarettes is assumed to provide behavioural and physiological cues for cannabis smoking and vice versa, which may explain the increased probability of relapsing among co-smokers (Agrawal et al., 2012; Moore & Budney, 2001). In line with this hypothesis, a study analysed adolescents in substance-abuse treatment and found that never-smokers and those non-smokers who quit using tobacco during their marijuana treatment had a lower risk of marijuana relapse than those who continued or initiated tobacco smoking during treatment (de Dios et al., 2009).

Despite the strong relationship between these substances, current interventions typically target only one substance while addressing the other marginally or not at all. The historical development of the treatment and prevention systems in many industrialised countries might explain the lack of combined interventions. While cannabis dependence is usually treated in the psychiatric care system, interventions for tobacco users are part of the general public health system (S. M. Hall & Prochaska, 2009; J. J. Prochaska, 2010). Recently, several reviews and a demand analysis identified a need for interventions tailored to co-smokers of tobacco and cannabis (Agrawal et al., 2012; Becker et al., 2013; Peters et al., 2012; Ramo et al., 2012). To date, one small pilot study evaluated individual cognitive behavioural therapy combined with nicotine replacement therapy (NRT) for co-occurring nicotine and cannabis dependence (Hill et al., 2013). The seven participants who completed the intervention reduced their tobacco use while maintaining their cannabis use level. Similarly, tobacco smoking cessation interventions integrated in treatments of alcohol or opioid dependence have achieved positive results (Dunn et al., 2009; Mueller et al., 2012; Nieva, Ortega, Mondon, Ballbè, & Gual, 2011), which indicates that tobacco cessation interventions do not undermine other substance abuse treatments. Instead, dual treatment programs generate putatively better outcomes with regard to one or both targeted behaviours (Baca & Yahne, 2009; S. M. Hall & Prochaska, 2009; J. J. Prochaska et al., 2004).

The current study aimed to test the feasibility, safety, and initial effectiveness of a group

cessation intervention for co-smokers targeting tobacco and cannabis use simultaneously. This study is the first to evaluate these aspects with regard to the dual-cessation of tobacco and cannabis use with an appropriate sample size and in a group setting. Furthermore, it is a novelty to examine dual abstinence from tobacco and cannabis.

Methods

Study Design and Procedure

This study used a within-participant design with pre-, post-, and 6-month follow-up assessments to evaluate the feasibility of an integrative group cessation intervention that targeted co-smokers of tobacco and cannabis. Two addiction treatment centres in Zurich and Winterthur, Switzerland, offered the courses between January and October 2013. The Ethics Committee of the Canton of Zurich reviewed and approved this study (KEK-StV-Nr.23/11), which was designed in accordance with the Helsinki declaration. All participants provided written informed consent. The study is registered at Current Controlled Trials (ISRCTN15248397).

Baseline data were collected via questionnaires administered during an information evening or via the post for participants who did not attend the information evening.

The end-of-treatment (EOT) assessment was conducted during the last session of the course. Participants completed a questionnaire and provided a saliva sample. To maximise response rates, we attempted to collect data from individuals who had discontinued treatment. Therefore, these individuals received the questionnaire and the salivette for the saliva sample via the post. Participants who did not return the questionnaire were contacted via telephone or e-mail and motivated to complete the questionnaire. If contact was not established or the participants reported that they did not receive or lost the questionnaire, then we resent the questionnaire. When the reminders were unsuccessful, participants received a brief version of the questionnaire that only assessed the primary outcomes.

The follow-up measurement was conducted six months after the designated quit date. All participants received a questionnaire and a salivette via the post. The measurement procedure was comparable with the EOT assessment, the only difference being that we resent the questionnaire up to three times before using brief online or phone questionnaires. Participants who did not complete the intervention were additionally contacted by phone or e-mail to assess their reasons for discontinuation. Moreover, 500 Swiss Francs were raffled to one of the participants who returned their completed questionnaire and saliva sample.

For recruitment, a press release announcing the intervention and the accompanying study was issued via local newspapers, television, and the radio to recruit participants. In addition, leaflets and brochures were distributed. Two social media platforms and an advertisement in the online edition of a popular free newspaper were used to recruit online. All recruitment methods referred potential participants to the intervention's website for more information. Finally, an information evening was offered. The publication regarding the development of the intervention provides a detailed description of the recruitment process (Becker et al., 2013).

Participants

The inclusion criteria for study participation were (1) an age of 18 years and older; (2) daily tobacco cigarette, pipe, or cigar smoking; and (3) cannabis smoking at least once per week. The exclusion criteria included (1) a current, serious psychiatric illness or a history of psychosis, schizophrenia, or bipolar type I disorder; (2) other smoking cessation treatment at study entry; and (3) an inability to read or write in German.

A total of 104 people were screened for eligibility. Of these, 12 declined to participate, six provided informed consent but never appeared at a course session, and three were excluded from participation because they no longer smoked both substances. Of the 83 participants who began the intervention, four participants were admitted to attend the courses

but not included in the study because they smoked cannabis less than once per week (n = 2) or were in treatment for psychosis (n = 2). Two participants were retrospectively excluded from the study: One participant admitted during the study that she had already quit using cannabis prior to the baseline assessment; the other participant did not return their informed consent form. Thus, 77 participants were included in the study.

Intervention

The intervention was structured into five to six weekly 2-hour group therapy sessions and guided by two course instructors. During the first implementation phase, three 5-session courses were conducted with 13, 16, and 11 participants. Based on the feedback provided by the course instructors, the course content was redistributed over six sessions. In the second implementation phase, four 6-session courses were conducted with 6, 8, 13, and 10 participants.

The treatment included therapeutic elements derived from motivational interviewing (Miller & Rollnick, 2002), cognitive behavioural therapy, the relapse prevention model (Marlatt & Donovan, 2005), and self-control practices. In addition, course instructors offered each participant one individual counselling session upon request and recommended NRT and varenicline. Furthermore, participants received a workbook and were expected to refrain from tobacco and cannabis use after the third session (the "quit day"). Participants who continued using tobacco, cannabis, or both were encouraged to make an additional attempt to quit. To avoid the attrition due to participant failure, the course instructors could promote reducing use or changing to a less harmful form of administration (e.g. orally or with a vaporiser) (Bennett, 2008) when participants failed to quit several times. A detailed description of the intervention has been published elsewhere (Becker et al., 2013).

Measures

Primary outcomes

The primary outcomes included the self-reported frequency of tobacco use (henceforth termed "cigarette use" because only one participant was tobacco pipe smoker, whereas all others smoked cigarettes), the frequency of cannabis use (including cannabis co-administered with tobacco; i.e. joints), and the presence of dual-abstinence from tobacco and cannabis. Baseline cigarette use was measured in terms of the daily amount of cigarettes smoked during a typical smoking day, corrected for the number of smoking days during the past month. Baseline cannabis use for the previous seven days was measured according to the timeline follow-back (TLFB) method (Hjorthøj, Hjorthøj, et al., 2012). At the EOT and 6-month follow-up, 7-day cigarette and cannabis use frequency were assessed using the TLFB method. Participants who reported that they did not use one substance were considered abstinent with regard to this substance. Dual-abstinence was defined as reporting neither cigarette nor cannabis use. Salivary cotinine was used to analytically verify self-reported dual-abstinence, with a cut-off value of 5-ng/ml cotinine. Participants who reported dual-abstinence but had a positive cotinine test were counted as non-abstinent. If this inconsistency could be explained via sustained NRT, then participants were counted as abstinent. Because the use of NRT was only assessed at EOT, this correction could not be applied for the follow-up assessment. Cannabis abstinence was not analytically validated because of the lack of methods of salivary delta-9-tetrahydrocannabinol (THC) verification that are valid and applicable under the sampling and transport conditions (D. Lee & Huestis, 2013). Furthermore, the course instructors were strongly opposed to collecting urine THC samples.

Secondary outcomes

Nicotine dependence was measured using the Fagerstrom Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Problematic cannabis use

was measured using the Cannabis Use Disorders Identification Test (CUDIT) (Adamson & Sellman, 2003). Problematic alcohol use was measured using the Alcohol Use Disorders Identification Test - Consumption (AUDIT-C) (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998). The German short version of the Beck Depression Inventory (BDI-V) (Beck & Steer, 1987; Schmitt, Altstötter-Gleich, Hinz, Maes, & Brähler, 2006) and the Beck Anxiety Inventory (BAI) (Beck, Epstein, Brown, & Steer, 1988; Margraf & Ehlers, 1995) were used to assess mental health. Continuous scales were used instead of cut-off values to better capture the variability across the range of symptoms for all variables. The CUDIT was administered at baseline and the 6-month follow-up; all other variables were additionally assessed at the EOT.

Treatment process measures

Intervention retention was defined as not missing more than one session, or missing two sessions but not the last session. The reasons for intervention attrition were assessed among the dropouts using a multiple-choice question in which more than one answer was acceptable (specified in Table 6); dropouts were also provided the opportunity to explicate additional non-listed reasons. This question was also used to determine intervention safety, defined as not being hospitalised due to course participation. Using semi-structured interviews conducted with the course instructors after course implementation, we assessed hospitalisation among intervention completers.

Participant satisfaction was measured with the item, "Would you recommend the course to a friend in a similar situation?" with a scale ranging from 0 ("definitely no") to 5 ("definitely yes") at the EOT assessment. In addition, at the follow-up participants were asked whether they had recommended the course to anyone.

Baseline variables

The demographic variables gender, age, highest educational attainment, and employment status were assessed at baseline. Furthermore, regular medication and lifetime use of cocaine

and ecstasy were measured. Readiness to quit tobacco and cannabis, respectively, was assessed using readiness rulers (Miller, 1999) with a scale ranging from 1 (“not at all”) to 10 (“very much”).

Data Analyses

We analysed the differences between study dropouts and completers with regard to the baseline variables. Given the small number of dropouts, we used Mann-Whitney *U* tests and Fisher’s exact tests.

To examine abstinence, descriptive tables were created to provide an overview of the number of participants abstinent from (1) cigarettes, (2) cannabis, or (3) both according to the self-report and the biochemical validation at the EOT and follow-up assessments. We reported abstinence rates based on complete case analyses (CCAs) and on an analysis in which all missing participants were regarded as not abstinent (MAU).

To analyse whether the frequencies of cigarette use, cannabis use, and the secondary outcomes changed over time, we used generalised estimating equations (GEEs). This method accounts for the correlated nature of within-participant repeated-measures data. One of the advantages of this method is that it is consistent with intent-to-treat analyses because it accounts for all participants, regardless of missing values on EOT or follow-up assessments (Twisk, 2013). An exchangeable working correlation matrix was applied to each model, and measurement time (i.e. baseline, EOT, and follow-up) was entered as a predictor. To model variables with distributions characterised by a high proportion of zeroes (e.g. nicotine dependence and the frequency of cigarette and cannabis use), negative binomial models with a log link function were applied. A normal model with an identity link function was chosen for all secondary outcomes except the FTND.

We also conducted exploratory subgroup analyses to examine whether participants who failed to achieve dual-abstinence but successfully quit one substance compensated for their

abstinence via the increased use of the remaining substance. Therefore, we calculated change scores for each substance by subtracting the use frequencies reported at the EOT and follow-up, respectively, from those reported at baseline. Then, we compared these change scores between abstainers of only one substance and participants who continued to co-smoke using Mann-Whitney *U* tests.

All analyses were conducted using IBM SPSS version 20.0 (IBM Inc, 2011).

Results

Participant Characteristics and Attrition Analysis

At the EOT and follow-up assessments, 60 (77.9%) and 62 (80.5%) participants, respectively, provided at least their self-report data concerning the frequency of cigarette and cannabis use over the last week. Of those who indicated dual-abstinence, 10 (90.9%) and 4 (60.7%) participants provided cotinine samples at the EOT and follow-up, respectively.

Table 5 shows the baseline characteristics of the sample and the comparison between participants who provided self-report data regarding their use frequency at the 6-month follow-up ($n = 59$) and those who did not ($n = 18$). Significance tests did not yield between-group differences.

Table 5. *Baseline participant characteristics and the differences between study completers (followed up after 6 months;* n = *59) and dropouts (*n = *18)*

Characteristics	**Total**	**Completers**	**Dropouts**	***P*-value**
Demographic characteristics				
Age in years, mean (SD)	32.4 (8.2)	32.5 (7.8)	32.0 (9.7)	.796
Women, n (%)	19 (24.7)	16 (27.1)	3 (16.7)	.535
Education, n (%) [a]				.591
Incomplete secondary	9 (11.8)	8 (13.8)	1 (5.6)	
Secondary	43 (56.6)	31 (53.4)	12 (66.7)	
Higher	24 (31.6)	19 (32.8)	5 (27.8)	

Characteristics	Total	Completers	Dropouts	*P*-value
Employed, n (%) [b]	62 (82.7)	48 (84.2)	14 (77.8)	.499
Tobacco smoking				
Cigarettes/pipes per day, mean (SD)	16.1 (9.0)	16.5 (9.6)	14.7 (6.8)	.404
Age of onset of tobacco use, mean years (SD)	15.7 (2.4)	15.7 (2.6)	15.7 (1.4)	.458
FTND score, mean (SD)	4.0 (2.0)	4.0 (2.1)	4.0 (1.7)	.950
Cannabis use				
Use frequency per day, mean (SD)	3.0 (1.9)	2.9 (1.8)	3.5 (1.9)	.219
Age of onset of cannabis use, mean years (SD)	16.6 (3.3)	16.8 (3.6)	15.8 (2.0)	.436
CUDIT score, mean (SD)	18.6 (7.1)	18.7 (7.6)	18.2 (5.1)	.597
Other substance use				
AUDIT-C score, mean (SD)	5.6 (2.3)	5.7 (2.1)	5.1 (2.9)	.145
Lifetime use of cocaine, n (%)	48 (62.3)	37 (62.7)	11 (61.1)	1.000
Lifetime use of ecstasy, n (%)	45 (58.4)	35 (59.3)	10 (55.6)	.797
Readiness to quit [c]				
Tobacco, mean (SD)	8.3 (1.8)	8.3 (1.8)	8.3 (1.8)	.865
Cannabis, mean (SD)	7.5 (2.2)	7.5 (2.2)	7.7 (2.3)	.521
Physical/mental health				
BDI-V score, mean (SD)	35.7 (19.1)	35.7 (19.3)	35.6 (18.8)	.914
BAI score, mean (SD)	12.7 (9.5)	12.5 (9.4)	13.2 (9.8)	.824
Regular use of medication, n (%)	9 (12.0)	8 (14.0)	1 (5.6)	.678

Note. Mann-Whitney U-tests and Fisher's exact tests; [a] missing values: n = 1; [b] missing values: n = 2; [c] Readiness to quit was measured using contemplation ladders ranging from 1 (not at all) to 10 (very much); AUDIT-C = Alcohol Use Disorder Identification Test - Consumption, scale ranges from 0 to 12; BAI = Beck Anxiety Inventory, scale ranges from 0 to 63; BDI-V = simplified Beck Depression Inventory, scale ranges from 0 to 100; CUDIT = Cannabis Use Disorder Identification Test, scale ranges from 0 to 40; FTND = Fagerstrom Test for Nicotine Dependence, scale ranges from 0 to 10; SD = standard deviation.

Treatment Participation, the Reasons for Course Disruption, and Participant Course Evaluations

Of the 77 study participants, 48 (62.3%) completed the intervention. While 25 participants (32.5%) attended all sessions, 11 participants (15.6%) attended fewer than 50% of the sessions, and one participant (1.3%) attended only one session. Only seven participants used individual counselling; the majority of these participants spoke only briefly with the course

facilitators before or after the course session or during the short break, but they did not arrange a separate counselling session.

Twenty-one (72.4%) of the 29 participants who discontinued the intervention provided reasons for course attrition (Table 6). There were no reports of any hospitalisations as a consequence of course participation.

At the EOT assessment, 57 participants responded to the question regarding whether they would recommend the intervention to someone else. The majority of these participants (33, 57.9%) chose the highest value of 5 (i.e. "definitely yes", $M = 4.2$, $SD = 1.1$). By the follow-up, 24 of 44 (54.5%) participants had already recommended the course to another person.

Table 6. *Reasons for intervention attrition, assessed among non-completers (multiple answers possible,* n = *21)*

Reasons for intervention disruption	***N***	**% of respondents**
I had severe problems due to the cessation (attempt).	3	14.3
Problems with concentration	1	4.8
Sleeping problems	3	14.3
Depressive symptoms	2	9.5
Distorted perceptions	1	4.8
Problems with breathing	0	0.0
Other	1	4.8
I had no longer had time for the course sessions.	8	38.1
I had already quit using tobacco before the Quit Day.	3	14.3
I had already quit using cannabis before the Quit Day.	3	14.3
I did not want to quit using tobacco (any more).	4	19.1
I did not want to quit using cannabis (any more).	2	9.5
I did not want to *simultaneously* quit using tobacco and cannabis (any more).	5	23.8
I felt that the intervention did not help me.	7	33.3
Other reasons	10	47.6

Primary Outcomes

A total of 32 participants (41.5%) reported either single or dual-abstinence at the EOT assessment. At the follow-up, 18 participants (23.4%) reported abstinence from one or both substances. Table 7 provides an overview of the number of abstinent participants based on the self-report and biochemical validation data, the response rates, and the corresponding abstinence rates for each time point. Of the 11 participants who indicated dual-abstinence at the EOT assessment, one did not provide a cotinine sample and was therefore regarded as not abstinent. Another two participants returned positive cotinine samples but were counted as abstinent because they were using nicotine patches. At the follow-up, two of the six participants who reported dual-abstinence did not return their cotinine sample and were counted as non-abstinent.

Table 7. *Seven-day abstinence rates at the end-of-treatment and 6-month follow-up assessments, N = 77*

Outcome	***n* abstinent**	***n* missing values**	**% of CCA sample**	**% of MAU sample**
End-of-treatment assessment				
Cigarette abstinence (self-report)	25	17	41.7	32.5
Cannabis[1] abstinence (self-report)	18	16	29.5	23.4
Dual-abstinence (self-report)	11	17	18.3	14.3
Dual-abstinence (cotinine-verified)	10	18	16.9	13.0
6-month follow-up assessment				
Cigarette abstinence (self-report)	8	18	13.6	10.4
Cannabis[1] abstinence (self-report)	15	16	24.6	19.5
Dual-abstinence (self-report)	6	17	7.8	10.0
Dual-abstinence (cotinine-verified)	4	19	6.9	5.2

Note. [1] including co-administered tobacco; CCA sample = complete cases only; MAU sample = missings treated as users.

As Table 8 and Table 9 summarise, the frequencies of cigarette and cannabis use significantly decreased over time.

Table 8. *Generalised estimating equation (GEE) models of use frequency and the secondary outcome measures over time*

Dependent variables	**Coefficient (*IRR/b*)**	***SE***	**95% *CI***	***P*-value**
Cigarette use frequency [a]	0.819	0.059	(0.730; 0.919)	.001
Cannabis use frequency [a]	0.699	0.073	(0.605; 0.807)	< .001
FTND [a]	0.687	0.082	(0.585; 0.807)	< .001
CUDIT [b]	-3.590	0.548	(-4.663; -2.517)	< .001
AUDIT-C [b]	-0.347	0.117	(-0.577; -0.117)	.003
BDI-V [b]	-5.948	1.335	(-8.565; -3.332)	< .001
BAI [b]	-3.143	0.532	(-4.186; -2.101)	< .001

Note. The predictor in every model is time; Time 1 = baseline, Time 2 = end-of-treatment assessment, Time 3 = 6-month follow-up assessment; CUDIT was measured only at Time 1 and Time 3; [a] models are based on a negative binomial model with a log link function; [b] models are based on a normal model with an identity link function; lower values represent better outcomes for all scales. AUDIT-C = Alcohol Use Disorder Identification Test - Consumption; BAI = Beck Anxiety Inventory; BDI-V = simplified Beck Depression Inventory; CI = confidence interval; CUDIT = Cannabis Use Disorder Identification Test; FTND = Fagerstrom Test for Nicotine Dependence; IRR = incident rate ratio, displayed for negative binomial models; SE = standard error.

Table 9. *The means and standard deviations of the primary and secondary outcomes measured at baseline, the EOT assessment, and the 6-month follow-up assessment among complete cases*

Outcome	**n** complete cases	**Baseline** Mean (SD)	**EOT** Mean (SD)	**Follow-up** Mean (SD)
Cigarette use frequency	54	16.23 (9.96)	5.49 (11.62)	10.76 (13.01)
Cannabis use frequency	54	2.99 (1.96)	1.14 (1.97)	1.60 (1.76)
FTND	38	3.76 (2.26)	1.13 (1.99)	1.92 (2.36)
CUDIT	39	18.41 (8.17)	--	11.33 (7.63)
AUDIT-C	40	5.20 (1.88)	4.82 (1.85)	4.70 (2.17)
BDI-V	40	34.43 (21.19)	25.00 (19.26)	23.72 (18.58)
BAI	40	11.92 (10.25)	7.85 (9.35)	5.84 (5.74)

Note. Lower values represent better outcomes for all scales. AUDIT-C = Alcohol Use Disorder Identification Test, Consumption, scale ranges from 0 to 12; BAI = Beck Anxiety Inventory, scale ranges from 0 to 63; BDI-V = simplified Beck Depression Inventory, scale ranges from 0 to 100; CUDIT = Cannabis Use Disorder Identification Test, scale ranges from 0 to 40; EOT = end-of-treatment assessment; FTND = Fagerstrom Test for Nicotine Dependence, scale ranges from 0 to 10; EOT = end of treatment; SD = standard deviation.

The results of the exploratory analyses of compensatory use after quitting only one substance are displayed in Table 10. According to the descriptive results, the use frequency did not

increase among participants who continued smoking two substances or those who quit one substance; rather, participants decreased their use. We did not detect group differences with regard to the amount of reduction. However, the respective sample sizes were low and, in the case of cannabis use frequency at the follow-up assessment, a significance test was omitted.

Table 10. *Mann-Whitney U tests, applied to compare the use frequency change scores between participants who quit one substance and those who continued using both*

Comparisons	**n**	**Baseline**	**EOT**	**Follow-up**	**Difference**	***p***
		M *(SD)*	*M* *(SD)*	*M* *(SD)*	*M* *(SD)*	
Cigarette use frequency of cannabis-only abstainers at EOT	6	23.7 (19.1)	20.3 (28.2)	--	-3.5 (12.6)	
Cigarette use frequency of co-smokers at EOT	42	15.5 (8.0)	5.2 (6.9)	--	-10.2 (7.5)	.142
Cigarette use frequency of cannabis-only abstainers at FU	7	26.1 (15.6)	--	25.8 (24.1)	-0.4 (10.7)	
Cigarette use frequency of co-smokers at FU	46	15.4 (7.9)	--	10.3 (8.9)	-5.2 (6.9)	.259
Cannabis use frequency of tobacco-only abstainers at EOT	14	3.2 (1.8)	1.0 (1.3)	--	-2.2 (1.7)	
Cannabis use frequency of co-smokers at EOT	35	2.9 (1.8)	1.6 (2.3)	--	-1.2 (2.5)	.188
Cannabis use frequency of tobacco-only abstainers at FU	2	5.5 (1.5)	--	4.1 (1.2)	-1.4 (0.3)	
Cannabis use frequency of co-smokers at FU	51	2.9 (1.8)	--	1.7 (1.7)	-1.2 (1.9)	--

Note. EOT = end-of-treatment assessment; M = Mean; SD = standard deviation.

Secondary Outcomes

Table 9 shows the descriptive results of the secondary outcomes, all of which improved from baseline at the EOT and follow-up assessments. The GEE modelling results revealed significant time effects for all secondary outcomes (Table 8).

Discussion

The results of this study support the feasibility of the evaluated integrative group cessation program. First, 77 co-smokers were included in the feasibility study, and recruitment succeeded. Furthermore, 62.3% of participants completed the intervention. This retention rate is similar to the rate achieved in the pilot study that examined individual treatment of tobacco and cannabis co-smokers (58.3%) (Hill et al., 2013). In addition, participants' high levels of satisfaction (based on their recommendation levels) illustrated feasibility. We did not find evidence of hospitalisation due to course participation, which suggests that the intervention is considerably safe. However, three participants reported experiencing severe problems due to their simultaneous cessation (attempts) among their reasons for discontinuing the intervention. This factor must be addressed when implementing the program in the future (e.g. in promoting the use of individual counselling, preparing participants for the possibility of severe problems, and motivating them to contact the course facilitators in the event they experience such problems).

Ten (13.0%) and four (5.2%) participants achieved cotinine-verified dual-abstinence from tobacco and cannabis at the EOT and the follow-up, respectively. The self-reported single-abstinence rates at the EOT and follow-up assessments were higher, i.e. for cigarettes 32.5% and 10.4%, respectively, and for cannabis 23.4% and 19.5%, respectively. The only other study of a combined intervention did not report abstinence rates (Hill et al., 2013).

Furthermore, participants reduced their use of cigarettes and cannabis and improved regarding all secondary outcomes during the study period. These findings indicate that the program is potentially effective. The subgroup analyses regarding the differential changes in the use frequency between the quitters of one substance and those who continued co-smoking indicated that quitting one substance does not lead to a compensatory increase in the remaining substance when both substances are targeted in an integrative treatment, such as the present one. A substitution effect has been a major concern with regard to implementing

tobacco smoking interventions within other substance abuse treatments (S. M. Hall & Prochaska, 2009).

One limitation of this study is that the study attrition limits the generalisability of the results. However, the dropout analysis revealed that participants who provided follow-up data did not differ significantly from dropouts with regard to their baseline characteristics. Another limitation is the lack of an analytical validation for cannabis abstinence. Although salivary cotinine samples are an appropriate measure to validate tobacco abstinence, a reliable method for detection of THC and/or its metabolite THC-carbonic acid and the interpretation of corresponding analytical findings, respectively, is still lacking (D. Lee & Huestis, 2013). Nevertheless, the TLFB assisted self-report is a valid measure of cannabis use frequency (Hjorthøj, Fohlmann, Larsen, Arendt, & Nordentoft, 2012; Hjorthøj, Hjorthøj, et al., 2012). An additional limitation of this study is that the presence of NRT, which might explain the inconsistencies between self-reported and cotinine-validated abstinences, was not assessed at the 6-month follow-up assessment.

Randomised trials must be conducted to evaluate the efficacy of integrative interventions compared with single interventions among co-smokers. Moreover, future studies should implement feasible blood or urine verification methods for cannabis abstinence and evaluate alternatives to a designated quit date for all participants and both substances. For instance, staggered quit dates for tobacco and cannabis might be useful because evidence suggests that recent cigarette abstinence does not decrease the likelihood of a cannabis relapse (Haney et al., 2013). Furthermore, a clinical comparison study found that withdrawal was more severe during simultaneous cessation than during single cessation; however, this difference was only for a short duration, and substantial inter-individual variability was reported (Vandrey et al., 2008). Finally, analysing how treatment goals other than dual-abstinence affect the treatment outcomes might be helpful in improving treatment success. For example, a tobacco-abstinence goal combined with a cannabis-use-moderation goal might be

an alternative because a study that evaluated a guided self-change treatment found that most cannabis users chose to reduce their cannabis use rather than to abstain (Sobell et al., 2006). However, a cannabis abstinence goal combined with a reduced tobacco use goal is also a possibility because tobacco cessation might be a barrier to seeking treatment (Budney et al., 2007): Cannabis users seem to be less likely to select an abstinence goal for tobacco use compared with tobacco-only smokers (Ramo et al., 2013).

The present study demonstrated the feasibility of an integrative group cessation program that targeted co-smokers of tobacco and cannabis. Clinicians treating participants with cannabis use disorders should not hesitate to also integrate treatment of cigarette use and vice versa.

PAPER 3. Effectiveness of Different Web-Based Interventions to Prepare Co-Smokers of Tobacco and Cannabis for Double-Cessation: A Three-Arm Randomised Trial

Becker, J., Haug, S., Sullivan, R., and Schaub, M. P.

Abstract

Background. The relationship between tobacco and cannabis use is strong. When co-smokers try to quit only one substance this relationship often leads to a substitution effect, i.e. an increased use of the remaining substance. Stopping the use of both substances simultaneously is therefore a reasonable strategy, but co-smokers report rarely to be ready for simultaneous cessation. Thus, the question of how co-smokers can be motivated for a simultaneous cessation attempt has arisen. In order to reach as many co-smokers as possible, we developed brief, web-based interventions which aimed at enhancing the readiness to simultaneously quit tobacco and cannabis use.

Objective. To analyse three different web-based interventions regarding their efficacy in enhancing co-smokers' readiness to stop tobacco and cannabis use simultaneously.

Methods. Within a randomized trial, three brief, web-based and fully automated interventions were compared. The first intervention combined assessment of cigarette dependence and problematic cannabis use with personalised, normative feedback. The second intervention was based on principles of motivational interviewing. As active psycho-educative control group, the third intervention merely provided information on tobacco, cannabis, and the co-use of the two substances. The readiness to quit tobacco and cannabis simultaneously was measured before and after the intervention, as well as eight weeks later. Secondary outcomes were cigarette and cannabis use frequency, measured at baseline and after eight weeks. A total of 2467 website-users were assessed for eligibility of tobacco and cannabis co-use and 325

participants were randomized and analysed.

Results. For the post-intervention assessment, generalised estimating equations (GEEs) revealed a significant increase in the readiness to quit tobacco and cannabis in the total sample, $B = 0.33$, 95% *CI* [0.10, 0.56], $p = .006$. However, this effect was not significant for the comparison between baseline and follow-up assessment ($p = .69$). Furthermore, no differential effects between the interventions were found. Moreover, there were no significant intervention or time effects for the frequency of tobacco or cannabis use.

Conclusions. In the new field of dual interventions for co-smokers of tobacco and cannabis, web-based interventions can increase short-term readiness to quit tobacco and cannabis simultaneously. The studied personalized techniques were not more effective than psychoeducation. The analysed brief interventions did not change frequency of tobacco and cannabis use.

Introduction

The Relationship between Tobacco and Cannabis Use

While smoking tobacco is the leading global cause of preventable death (World Health Organisation, 2011), cannabis is the most widely used illicit drug (UNODC, 2012) and is associated with a range of physical and mental health problems (Caldeira et al., 2012; W. Hall & Degenhardt, 2009). Both substances are often used together, as the majority of cannabis users also smoke cigarettes. In a study in the United States, 74% of the marijuana users smoked cigarettes, compared to 29% of the nonusers (Richter et al., 2005). Furthermore, cannabis use is reportedly more common among cigarette smokers than it is among non-smokers. In the National Survey on Drug Use and Health (NSDUH) in the United States, the 30-day prevalence of cannabis use was 35% among tobacco smokers and only 9% among non-smokers (Substance Abuse and Mental Health Services Administration, 2013). In a similar survey in Switzerland, cannabis use in the previous 12 months was reported by 28% of

the adolescents who smoked tobacco daily compared to 9% and 2% of the adolescents who were ex- and never-smokers, respectively (Radtke et al., 2011).

The mechanisms that link the use of both substances are assumed to go beyond the mechanisms that explain the co-use of drugs in general (Agrawal et al., 2012). For instance, both substances are usually smoked (have a shared route of administration) and are often used simultaneously (co-administration), i.e. tobacco is added to cannabis joints ('mulling') or is smoked directly after cannabis ('chasing') (Agrawal et al., 2012; Peters et al., 2012). In Switzerland, 97% of cannabis users smoke cannabis joints mixed with tobacco (Baggio et al., 2013).

In the context of cessation, the relationship between both substances is often problematic. For instance, tobacco smokers who also consume cannabis seem to make fewer efforts to quit tobacco (Ford et al., 2002) and tend to be less successful in quitting tobacco compared to tobacco-only smokers (Abrantes et al., 2009). Furthermore, the cessation of one substance is frequently accompanied by an increased use of the other (Akré et al., 2010; Amos et al., 2004; Copersino et al., 2006), and cessation programs that exclusively address tobacco appear to be less effective for co-smokers of cannabis (Gourlay et al., 1994; Moore & Budney, 2001).

Interventions for Tobacco and Cannabis Use

Despite these findings, interventions have typically targeted tobacco or cannabis use alone and have rarely addressed both substances simultaneously. One explanation for the separate treatments may be that in many industrialised countries, the treatment of cannabis dependence is provided by psychiatrists, while interventions for tobacco smokers are part of a more general public health system (S. M. Hall & Prochaska, 2009; J. J. Prochaska, 2010). However, the body of literature on the relationship between tobacco and cannabis use is growing, and authors of recent reviews perceive a demand for double interventions targeting tobacco and

cannabis simultaneously (Agrawal et al., 2012; Peters et al., 2012; Ramo et al., 2012). In line with this notion, a preliminary study of the development of such a program has indeed revealed this demand (Becker et al., 2013). The experts and the co-smokers who participated in the preliminary study considered a dual cessation intervention as feasible.

However, the participants also expected only modest readiness to simultaneously quit tobacco and cannabis use, as half of the surveyed co-smokers were unaware of the association between tobacco and cannabis use (Becker et al., 2013). Due to this finding, we developed three brief online interventions to enhance co-smokers' awareness of the relationship between the substances as well as their readiness to simultaneously quit each substance. The purpose of the current study was to evaluate these online interventions and examine how co-smokers' readiness to simultaneously quit tobacco and cannabis can be augmented. Motivational constructs such as the stages of change and the readiness to quit have been shown to predict the subsequent engagement in interventions (Biener & Abrams, 1991; Hogue, Dauber, & Morgenstern, 2010) and abstinence (Velicer, Redding, Sun, & Prochaska, 2007).

Because of its easy access and ubiquitous presence, the Internet arose as a potentially effective medium to reach a large number of co-smokers who might be unaware of the relationship between their tobacco and cannabis use. Personalised, normative feedback is one motivational technique that can be applied to web-based interventions for substance use. Based on the social norms approach (Perkins, 2003), such interventions typically include self-assessment sections and feedback sections in which the participants' behaviour is compared to a reference sample. The overestimation of substance use by others is common and is positively associated with one's own use (Bertholet et al., 2013). Web-based social norm interventions use this association and aim to correct the participants' erroneous perceptions. Mostly studied among college students and targeting alcohol use, web-based norms approaches for interventions have yielded promising results (Moreira, Smith, & Foxcroft, 2009).

A further established technique for building motivation is motivational interviewing (MI), which uses a client-centred, directive counselling style to explore and reduce ambivalence and increase the intrinsic motivation for change (Miller & Rollnick, 2002). Brief face-to-face interventions based on MI have been found to be effective in reducing cannabis use (Stephens et al., 2000) and may assist in smoking cessation (Lai, Cahill, Qin, & Tang, 2010). MI in web-based interventions is usually applied as a chat-intervention but is not fully automated. However, the first promising results of fully automated MI have recently been revealed by a computer-based intervention targeting perinatal drug use (Ondersma, Chase, Svikis, & Schuster, 2005).

For this study, we developed three web-based interventions that apply the above-mentioned techniques, i.e. normative feedback and MI. For an active control group, we used web-based psychoeducation. In addition, to maintain the low threshold for Internet access and keep the study dropout rate as low as possible, the interventions were designed as brief single-session interventions.

Aims of the Study and Hypotheses

The main aim of this study was to evaluate three web-based interventions regarding their effectiveness in enhancing co-smokers' readiness to quit both tobacco and cannabis simultaneously. Our first hypothesis (H1) was that the tested interventions would be effective in enhancing readiness to simultaneously quit tobacco and cannabis use. Thus, we assumed a significant within-subjects effect for assessment time. Because particular interactive interventions that were tailored to individuals have shown promising effects in aiding smoking cessation (Civljak et al., 2013), our second hypothesis (H2) was that interactive and tailored interventions, i.e. an intervention based on MI and an intervention providing normative feedback, would more effectively enhance co-smokers' readiness to quit tobacco and cannabis use simultaneously compared to mere psychoeducation. Because MI has shown

promising effects as a motivational enhancement strategy for cannabis users (D'Amico, Miles, Stern, & Meredith, 2008), we additionally hypothesised that this intervention would outperform the effectiveness of the normative feedback intervention (H3).

Furthermore, this study aimed to evaluate the three interventions as they pertained to secondary outcome variables, i.e. the frequencies of tobacco and cannabis use. We had the same hypotheses for these outcomes as those explained above.

Methods

Study Design and Setting

To test our hypotheses, we conducted a three-armed randomised trial (ISRCTN56326375) with pre-, post- and 8-week follow-up assessments. The three single-session interventions were web-based and fully automated. The baseline assessment (t0) was conducted at the beginning of the intervention session, and the post-intervention assessment (t1) immediately followed the intervention. After eight weeks, the subjects were re-assessed (follow-up, t2) by phone or online. However, our primary focus was set on the immediate post-intervention assessment because our primary outcome, the readiness to simultaneously quit tobacco and cannabis, would not be applicable to those participants who stopped smoking tobacco or cannabis after the intervention at t2.

The interventions were integrated within a German-language website (www.i-cut.ch), which, besides the interventions, contained information about an integrative group cessation course for co-smokers of tobacco and cannabis. This cessation course is evaluated in a separate study (ISRCTN15248397).

Participants could enter the current study in one of two ways. First, they could enter it directly from the start page of the website, where participants could choose between "getting more information about the course" and "learning more about my use of tobacco and cannabis". They were then directed to the course information pages or to the intervention

session, respectively. We chose the cover term "learning more about my use of tobacco and cannabis" for the intervention session to attract co-smokers who were not seeking treatment. The second way to enter the study was to switch there from the course information pages by clicking a teaser that was displayed on the right side of each information page. It was also labelled "learning more about my use of tobacco and cannabis" (Figure 2). Conversely, participants could switch from the intervention session to the course information pages by clicking a hyperlink ("register now for the tobacco and cannabis cessation course"). This hyperlink was present on every page of the intervention, and the participants who clicked on it were directed to the course information pages and dropped out of the present study. Figure 3 shows a sample page of the intervention and the hyperlink.

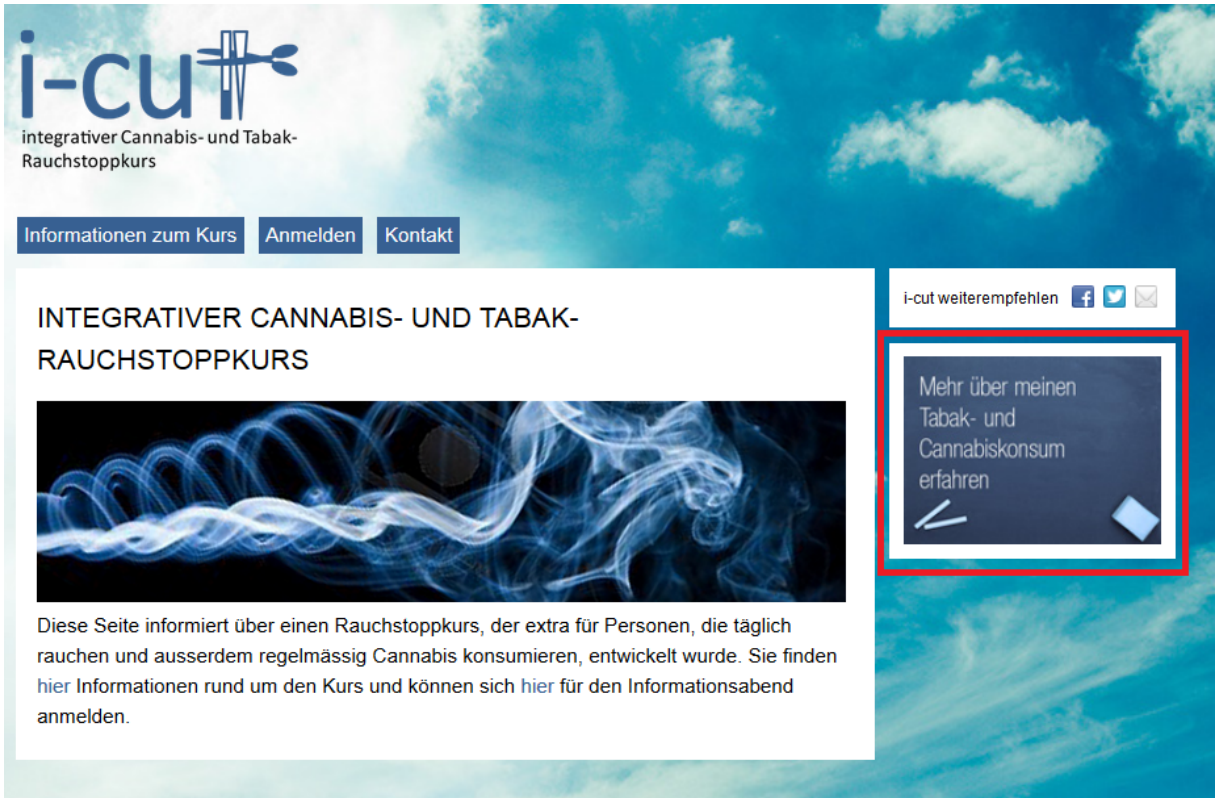

Figure 2. Screenshot of the teaser (red square) for the web-based intervention as it was displayed on the course information pages.

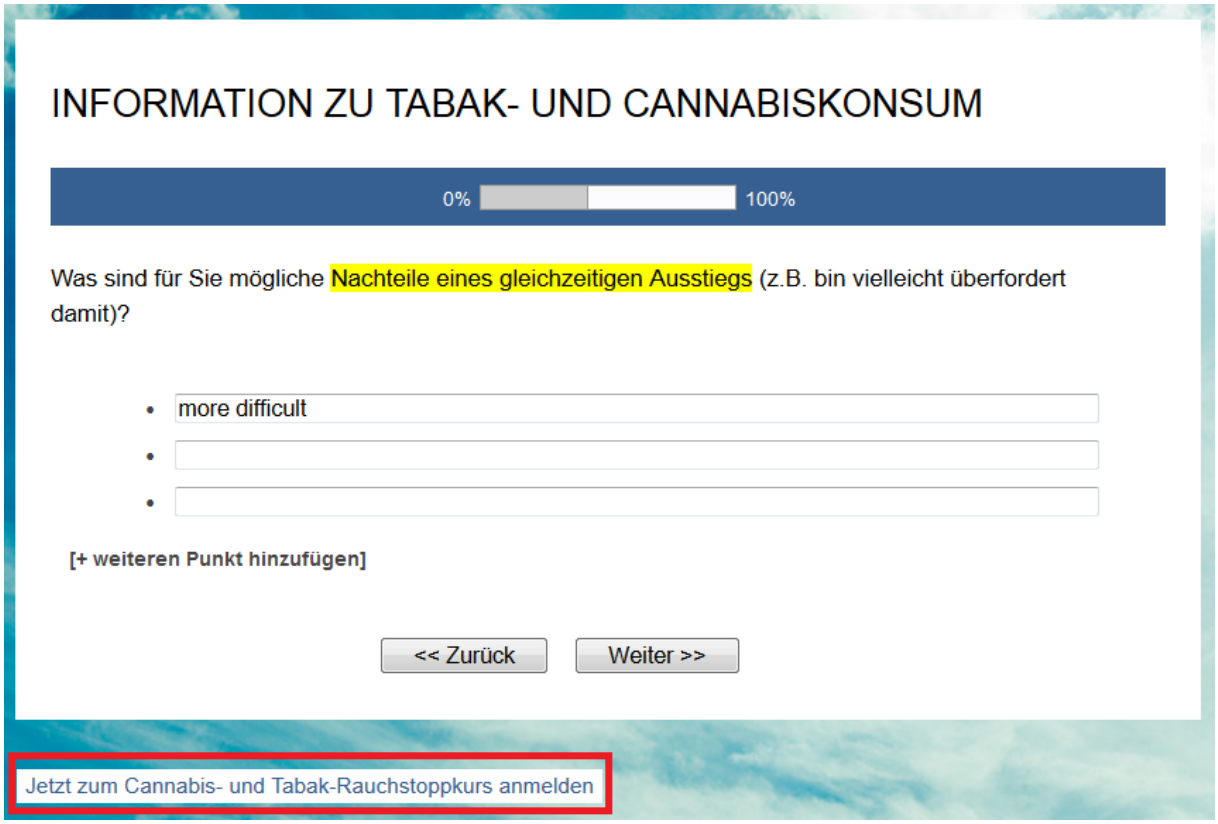

Figure 3. Screenshot of the intervention (intervention arm: motivational interviewing) and the hyperlink (red square) that directed participants to the web pages with information about the smoking cessation course.

Eligibility and Recruitment

The inclusion criteria for study participation included any tobacco use during the past four weeks and any cannabis use during the past six months. As implicit inclusion criteria, participants had to speak German and be computer literate. There were no age restrictions or other exclusion criteria.

Recruitment for the present study ran parallel to recruitment for a feasibility study of the above-mentioned smoking cessation course for co-smokers of tobacco and cannabis. This was conducted in Zurich and a neighbouring city. The recruitment strategy has been described in the publication on the course development (Becker et al., 2013). Briefly, recruitment was carried out online and offline. First, a press release about the course was issued, which resulted in several reports in local newspapers and on radio and TV stations. Furthermore,

brochures and leaflets were sent to counselling centres for addiction prevention and treatment, psychiatrists, and health (care) centres in the canton of Zurich and in the bordering cantons. Additionally, two social media platforms and a teaser in the online edition of a popular free newspaper were used for recruitment. All of these referred to the start page of the website for more information.

To maximise the response rates, study participants were also offered the opportunity to participate in a lottery for three vouchers valued at 300, 200, or 100 Swiss Francs after they completed the first session, including the second measurement. Additionally, a second lottery for the same values served as an incentive to participate in the follow-up measurement. The data were collected from January to December 2012.

Procedure

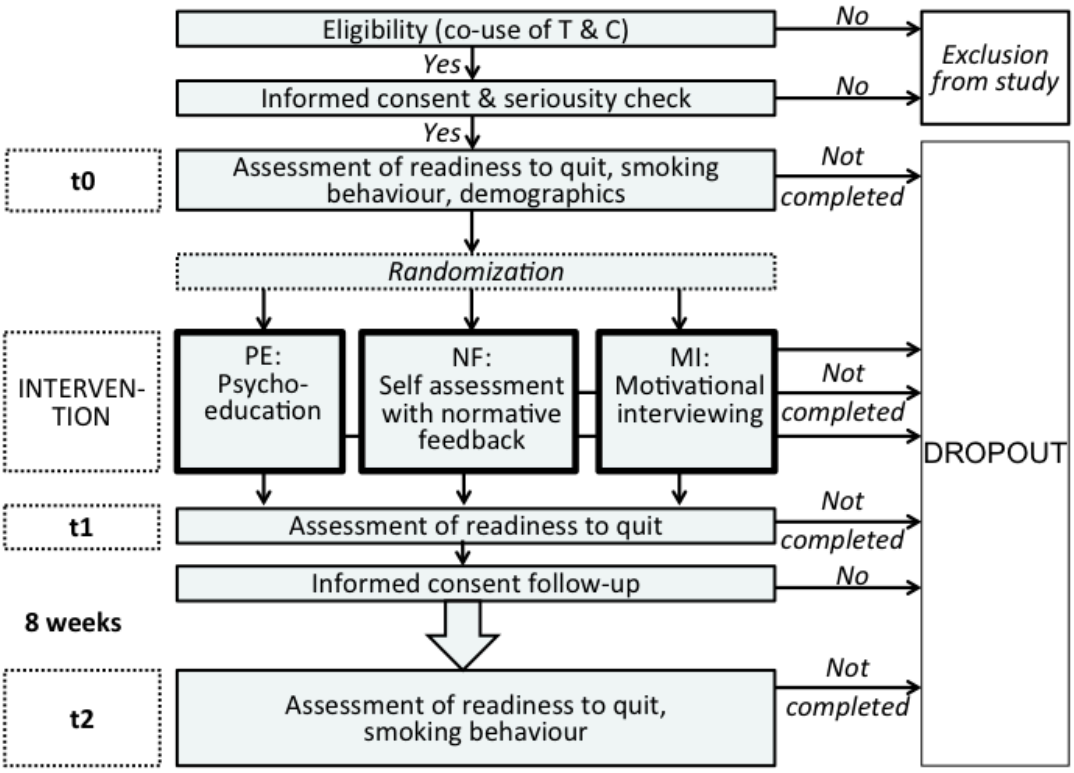

Figure 4. Study procedure.

Figure 4 illustrates the study procedure in detail. The initial questions presented to potential participants were used to check the inclusion criteria. If the users met these criteria, they were

informed about the opportunity to participate in a study aiming to improve the website's information offerings. Those who did not fulfil the inclusion criteria or did not provide informed consent were excluded from the study and were referred to a webpage that contained information on tobacco and cannabis use, which was also provided in the psycho-educational intervention (see below).

Once the baseline measurement (t0) was completed, participants were randomly assigned to one of three possible interventions. After finishing the intervention, participants were reassessed (post-intervention, t1) and informed about the 8-week follow-up assessment (t2). To keep the threshold for entering the study as low as possible, the information about the follow-up assessment was only provided at this point. This was done because the main aim of the present study was to enhance the readiness to simultaneously quit tobacco and cannabis between t0 and t1. Participants who provided informed consent for the follow-up assessment could indicate whether they wanted to answer the follow-up questionnaire online or over the phone. At the end of the session, participants were referred to the webpage of the group cessation program if they were interested.

For the follow-up assessment, participants were contacted after eight weeks via their chosen mode (i.e. via email including a link to the online questionnaire or via telephone). Those who preferred to answer the questionnaire online received an email reminder after about two weeks if they had not yet completed the online questionnaire. Those who chose the telephone questionnaire were contacted up to ten times.

Interventions

General Information and Technological Background

Participation in the interventions was free, and access was open for every eligible participant. The delivery of interventions was fully automated. The open source software *LimeSurvey* (Version 1.91) was used to program the survey and the interventions.

As described below, the interventions varied in the extent to which they were interactive with the participants. Additionally, the interventions differed in the way in which each was tailored to the responses that the participants had given during the baseline assessment and during the interventions themselves.

Intervention 1: Normative feedback (NF)

The first intervention contained a combination of self-assessment and personalised normative feedback (NF). It consisted of three sections, including one each for tobacco use, cannabis use, and co-smoking. In the first and second sections, participants began by completing a questionnaire (the Fagerstrom Test of Nicotine Dependence, FTND (Bleich, Havemann-Reinecke, & Kornhuber, 2002; Heatherton et al., 1991), and the Cannabis Use Disorder Identification Test, CUDIT (Annaheim, Rehm, & Gmel, 2008), respectively). Participants received feedback following each questionnaire. Feedback was individually tailored to participants using an algorithm based on the results from the FTND, the CUDIT, and the baseline data. Based on the social norms approach, each participant's reported frequency of smoking was presented in relation to the normative data from Swiss community samples. Afterwards, participants received feedback about their questionnaire scores and whether their responses met criteria for dependency (FTND) and/or problematic use (CUDIT), respectively. Explanations of "cigarette dependence" and "problematic cannabis use" were also given. Each substance-specific section concluded with brief recommendations for cessation or moderation of use. In addition, at the end of the intervention, information was provided that simultaneously accounted for the participant's use patterns of tobacco and cannabis. Participants who regularly smoked both tobacco and cannabis were informed about the group cessation course and referred to the end of the post-intervention assessment for further information. Participants who used either just one of the substances or both less regularly received contact details for the appropriate consulting services. Table 11 presents examples of translated feedback.

Table 11. *Examples of feedback provided during the normative feedback intervention to a participant who smoked more than five cigarettes per day and used cannabis less than once per week*

Intervention step	**Example**
Feedback on tobacco use frequency	You indicated smoking an average of 12 cigarettes per day. Among Swiss males, 70% do not smoke at all. Only approximately 10% smoke more than you.
Feedback on cigarette dependence	Your nicotine dependence is classified as high. Your result means that quitting may be more difficult for you compared to people with low dependence. Presumably, you will experience withdrawal symptoms. Nevertheless, these symptoms will weaken soon, and there are helpful aids against them. For instance, nicotine replacement therapy is very effective. However, quitting smoking requires more than just getting through the withdrawal symptoms. For example, you should develop individual strategies which help you cope with risk situations in which the temptation of smoking a cigarette is high. Professional support (e.g. a smoking cessation course) can be very helpful in developing such strategies.
Feedback on cannabis use frequency	During the past four weeks, you used cannabis two or three times. A survey revealed that 89% of Swiss adolescents and young adults do not use cannabis at all. Only 4% use it more often than you.
Combined feedback	Of course, it is not easy to quit both substances simultaneously for good, especially after having smoked cigarettes on a regular basis. You can ask for support at [name of a centre for addiction counselling and treatment] and mention that you also smoke joints occasionally.

Intervention 2: Motivational interviewing (MI)

The second intervention was based on the principles of motivational interviewing (MI). It was highly interactive and tailored to the participant, and it used a selection of MI techniques that could be adapted to a web-based intervention, such as open-ended questions, affirmative

feedback, and periodic summaries. The aim of this intervention was to promote participants' self-reflective thinking about their own smoking behaviour and intentions to change it and to enhance their self-confidence in the ability to change. This was done in different tasks, such as decisional balance tasks, in which participants wrote down personal pros and cons of stopping tobacco use, cannabis use, or both simultaneously (Figure 3). Participants were also asked to write down what advice they would give to a co-smoking friend and to indicate their confidence in successfully stopping tobacco, cannabis, or both simultaneously on a confidence ruler. Participants received feedback, including a brief summary of their indicated change in self-confidence and a brief informational text about the simultaneous cessation of tobacco and cannabis use. To further enhance their self-confidence, participants were asked to list any behaviour that they had successfully changed in the past and to write down the names of persons in their network who could provide some level of social support during an attempt to quit smoking. Participants who, at baseline, had low levels of motivation to quit smoking and cannabis simultaneously received a further task.

Intervention 3: Psychoeducation (PE)

The third intervention was the active control group and provided psycho-educational information (PE) about tobacco and cannabis use. The information was thematically subdivided into smaller subsections. Participants had to read the sections in sequential order. Several terms and concepts that some readers may not know (e.g. "carbon monoxide") were explained in a small text box that appeared when mousing over the word of interest (Figure 5). The PE intervention started with an explanation of the association between the two substances with regard to the initiation and cessation of their use, their linking mechanisms, and the potential health consequences of their co-use. The next chapter contained information about the short- and long-term consequences of tobacco use, tobacco dependence, and the cessation of tobacco use and was followed by an analogous chapter on cannabis. The final chapter provided information about changing smoking behaviour and addressed smoking

reduction versus abstinence, the simultaneous cessation of tobacco and cannabis use, and support during the cessation process. At this point, the group cessation program was mentioned and participants were referred to the end of the post-intervention assessment to receive further information.

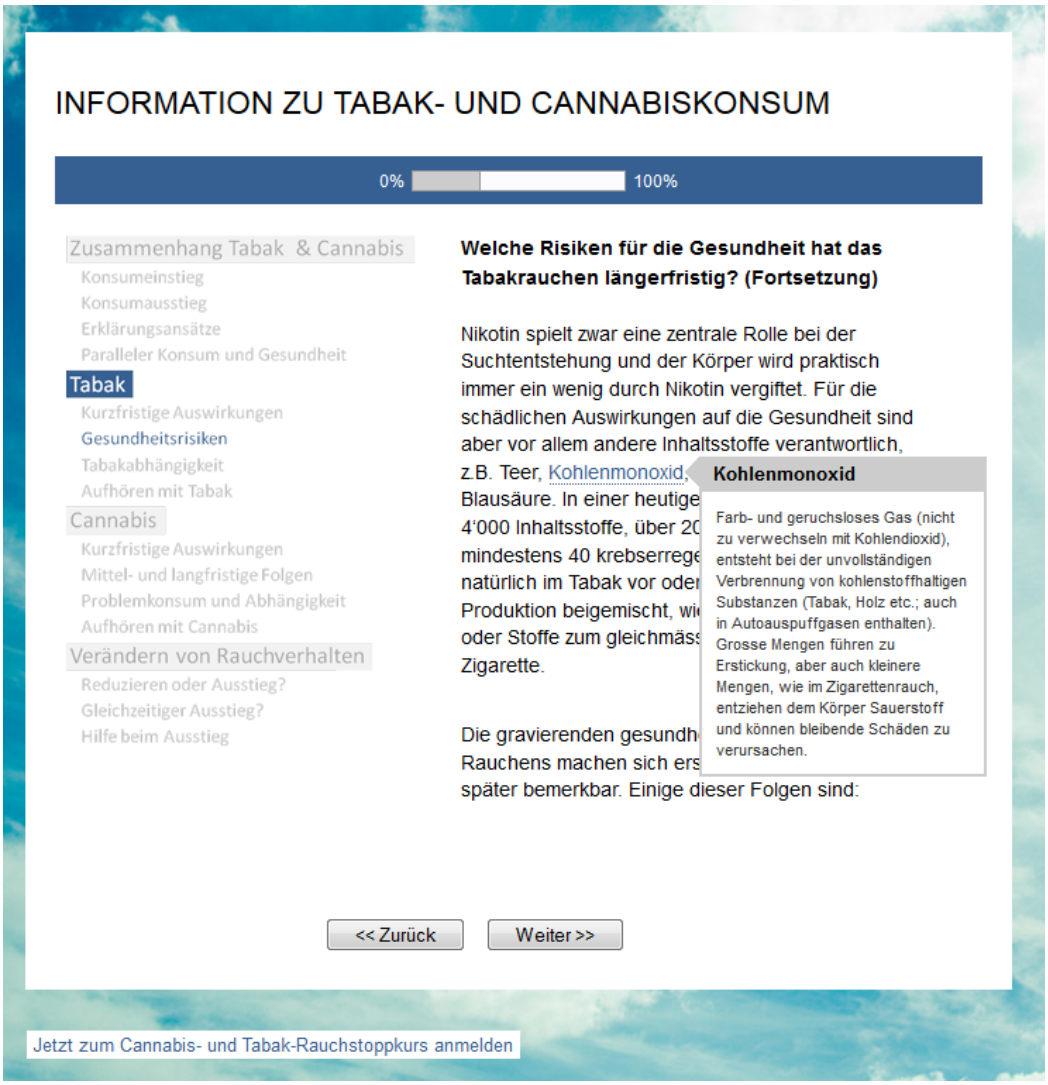

Figure 5. Screenshot of a section in the psycho-educational intervention.

Outcome Measures

The primary outcome measure was participants' readiness to quit the use of tobacco and cannabis simultaneously. Readiness was measured at all three time points by the question "To what extent are you ready to quit tobacco and cannabis simultaneously?" Participants

indicated their readiness on a ruler ranging from 1 (“not at all”) to 10 (“very much”). The item was designed based on the contemplation ladder (Biener & Abrams, 1991), which is especially suited to measure early stages of readiness. In addition, a comparison of the readiness ruler to other measures of motivation to change revealed its good concurrent and predictive validity and its superior clinical utility when its brevity and ease of administration are considered (Maisto et al., 2011).

Secondary outcomes included the self-reported frequency of tobacco and cannabis use at baseline (t0) and at the 8-week follow-up (t2). The frequency of tobacco use was defined as the daily amount of cigarettes smoked during a typical smoking day, corrected for the number of smoking days during the past month. The frequency of cannabis use in the past week was assessed using 7-day timeline follow-back question (Norberg, Mackenzie, & Copeland, 2012).

Baseline Measures

At baseline, we assessed key demographic variables, i.e. age, sex, highest educational attainment, and nation of residence. Furthermore, we measured participants’ smoking history, i.e. age of onset of tobacco and cannabis use, and the number of prior attempts to quit tobacco use, cannabis use, or both simultaneously.

Statistical Analysis

According to the intention-to-treat principle, all participants who provided informed consent and communicated their intention to provide serious answers to the questionnaire were included in the analyses. Using the Amelia II multiple imputation package of the R software environment for statistical computing, Version 2.15.3 (R Core Team, 2013), we imputed 20 datasets. In a simulation study using data from an online self-help program for problem drinkers, Amelia II outperformed other methods of multiple imputation (Blankers, Koeter, & Schippers, 2010). Hypotheses tests were performed using each data set separately and were

pooled afterwards (intention-to-treat analysis). To determine the robustness of our results to the analytic strategy, we also performed complete case analyses considering only participants who provided data at all three assessments.

Trial arm differences in baseline measurements were tested using analysis of variance (ANOVA) and the Kruskal-Wallis-test for continuous variables and chi-square tests for categorical variables, depending on each variable's parametric properties. The differential loss to the post-intervention assessment and the follow-up assessment was analysed using chi-square tests.

To analyse the primary and secondary outcome variables, we used generalised estimating equations (GEE) that consider the correlated nature of repeated measures. In the GEE models used to test H1, the only predictor was measurement time. The GEE models used to test differential effects of the interventions (H2 und H3) considered five variables: measurement time, intervention type, interaction of time and intervention type, gender, and baseline readiness to quit cannabis. Measurement time was entered as a dummy-coded categorical variable, with the baseline measurement being the reference category. In the GEEs that modelled the secondary outcomes, time was binary because the frequency of use was measured only at t0 and t1. Interaction effects examined whether the intervention type had a differential effect on the changes in the outcome variable over time in the two compared groups, thus answering H2 and H3. Gender and baseline readiness to quit cannabis use were included as control variables because they differed between the two groups at baseline.

To directly test the postulated differential effects by intervention group, the interventions were grouped by hypothesis and analysed in two separate models. One model contrasted the PE intervention as a reference category with the combination of MI and NF (H2), whereas the second model contrasted the two interactive, personalised intervention types, NF and MI, with each other (H3).

All GEE models were based on an unstructured working correlation matrix. For the

models of readiness to quit, a normal model with an identity link function was chosen. In the models of frequency of tobacco and cannabis use, we used a negative binomial model with a log link function.

The alpha level was set at $\alpha = .05$, and the analyses were performed using R (R Core Team, 2013), Stata 12.1 SE (StataCorp., 2011), and IBM SPSS Statistics Version 20 (IBM Inc, 2011).

The power calculation was based on the outcome of primary interest, the readiness to simultaneously cease tobacco and cannabis use, as measured directly after the intervention (t1). For a 3 x 2 repeated measurements design, a total sample size of $N = 246$ was required to detect small effects with a 2-sided type I error rate $\alpha = .05$ and a power of 80% (Bortz & Döring, 2006, p. 633).

Ethical Approval and Study Registration

The study was designed in accordance with the Helsinki declaration and was approved by the ethics committee of the Canton of Zurich, Switzerland (approval number: KEK-StV-Nr. 23/11, June 27, 2011, and amendment for the internet-based intervention, November 11, 2011). The study is registered at current controlled trials (http://www.controlled-trials.com, ISRCTN56326375).

Results

Baseline Characteristics, Response Analysis, and Intervention Duration

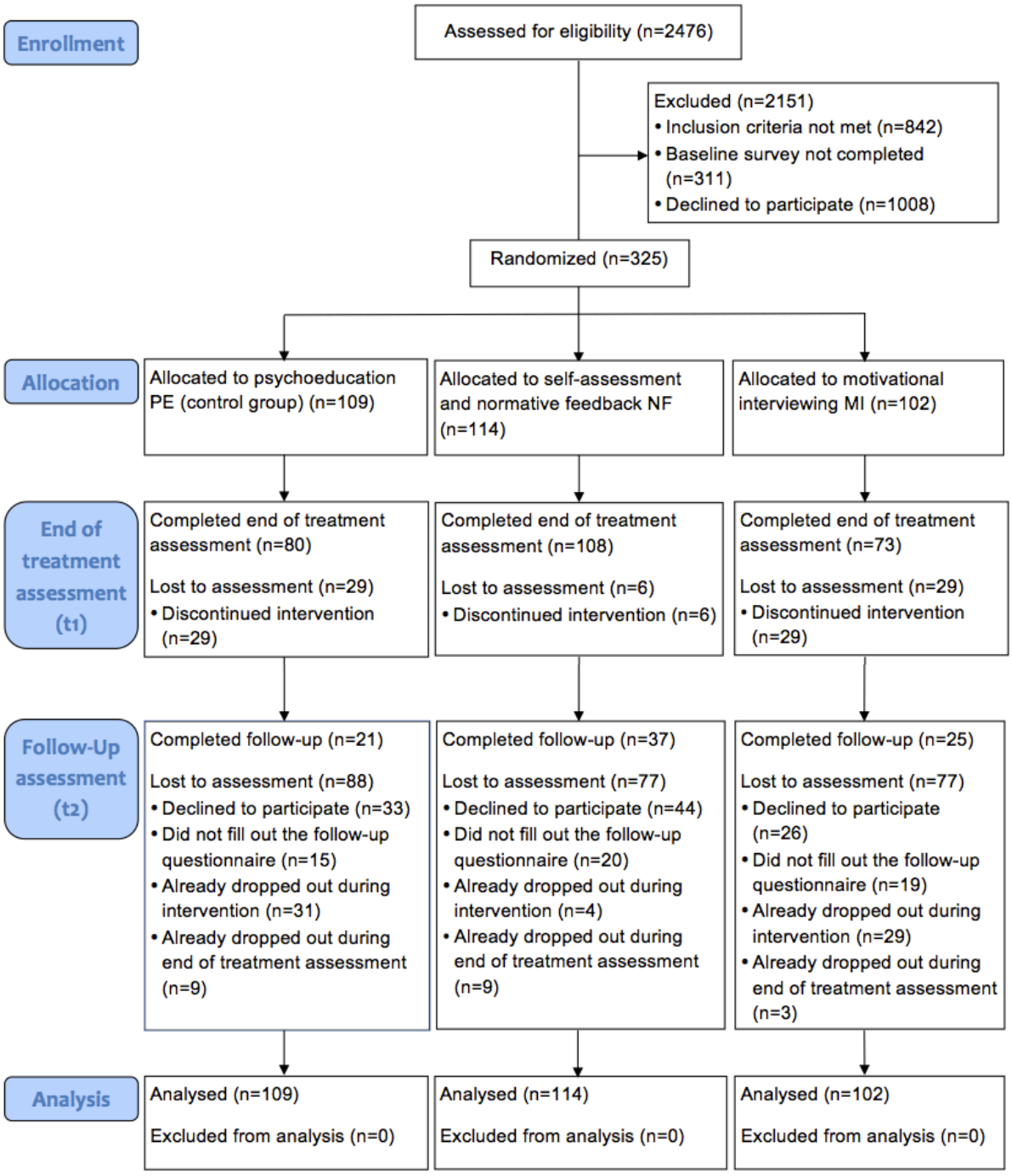

Figure 6. Participant flow chart.

As shown in Figure 6, of the 2476 users who were assessed for eligibility, 1468 met inclusion criteria. Of those, 325 (22.1%) provided informed consent, completed the baseline

assessment, and could therefore be randomised into one of the intervention groups. Of them, 261 (80.3%) participants completed the intervention, and 83 (25.5%) participated in the follow-up assessment.

Table 12 compares the baseline variables across the intervention groups. Except for the relatively high percentage of women (30.3% vs. 14.9% in the NF and 17.6% in the MI interventions) and the higher readiness to quit cannabis use in the PE intervention, no baseline variables differed significantly across the three groups.

Table 12. *Trial arm differences in baseline variables*

Baseline Variable	**PE**	**NF**	**MI**	**Significance**	
				F (df) / χ^2 (df)	p
N	109	114	102		
Females, n (%)	33 (30.3)	17 (14.9)	18 (17.6)	8.91 (2)	.01
Age in years, M (SD)	30.5 (9.5)	29.2 (9.6)	29.6 (9.5)	1.22 (2)	.54
Tobacco use frequency (cigarettes per day), M (SD)	12.5 (7.7)	12.0 (8.2)	13.6 (8.6)	2.16 (2)	.34
Cannabis use frequency (times per day), M (SD)	2.5 (1.9)	2.3 (2.3)	2.3 (2.2)	3.54 (2)	.17
Age of tobacco use onset, M (SD)	16.0 (3.2)	15.8 (2.9)	16.0 (2.7)	0.17 (2,322)	.84
Age of cannabis use onset, M (SD)	17.1 (4.4)	16.3 (3.4)	16.5 (3.1)	1.09 (2,322)	.34
Prior simultaneous cessation attempt, n (%)	32 (29.4)	38 (33.6)	32 (31.4)	0.47 (2)	.79
Readiness to quit tobacco, M (SD)	7.2 (2.4)	7.0 (2.7)	7.5 (2.4)	1.42 (2)	.49
Readiness to quit cannabis, M (SD)	5.8 (3.0)	4.8 (3.3)	5.1 (2.9)	6.03 (2)	.049
Readiness to quit tobacco and cannabis simultaneously, M (SD)	5.2 (2.8)	4.7 (3.0)	5.0 (2.9)	2.40 (2)	.30

Note. PE=psychoeducation, NF=normative feedback, MI=motivational interviewing.

During the intervention and the post-intervention measurement (t1), 85 (26.2%) participants dropped out, and 98 (30.2%) did not provide informed consent for the follow-up assessment. A total of 85 (26.2%) participants provided follow-up data. The drop-out analysis revealed no

trial arm differences in the percentage of participants who did not participate in the follow-up assessment, $\chi^2_2 = 5.20$, $p = .07$. However, the groups significantly differed with regard to their participation in the post-intervention assessment, $\chi^2_2 = 23.23$, $p < .001$. Specifically, the highest participation rate in the follow-up was achieved in the NF intervention (94.7%) compared to participants in the PE (73.4%) and MI interventions (71.6%).

Regarding their duration, the interventions differed significantly. Overall, participants remained in the intervention sessions for an average of 25.5 minutes ($SD = 33.0$), including the baseline and post-intervention assessments. While the participants in the NF condition finished the session after $M = 17.0$ minutes ($SD = 9.1$) on average, participants in the PE ($M = 28.4$, $SD = 38.4$) and the MI ($M = 28.9$, $SD = 41.6$) interventions stayed significantly longer, $F(2, 322) = 4.7$, $p = .01$.

Effects of the Intervention on Readiness to Simultaneously Quit Tobacco and Cannabis Use

As shown in Figure 7, the readiness to quit tobacco and cannabis use simultaneously slightly increased in all interventions between t0 and t1 and decreased thereafter. The GEE analysis used to test time effects in the total sample (H1) revealed that readiness to simultaneously quit was significantly higher at post-intervention compared to baseline, $B = 0.33$, Standard Error $SE = 0.12$, 95% CI [0.10, 0.56], $p = .006$. At the follow-up assessment; however, the readiness to simultaneously quit was no longer significantly higher compared to the baseline level, $B = -0.13$, $SE = 0.33$, 95% CI [-0.81, 0.54], $p = .69$.

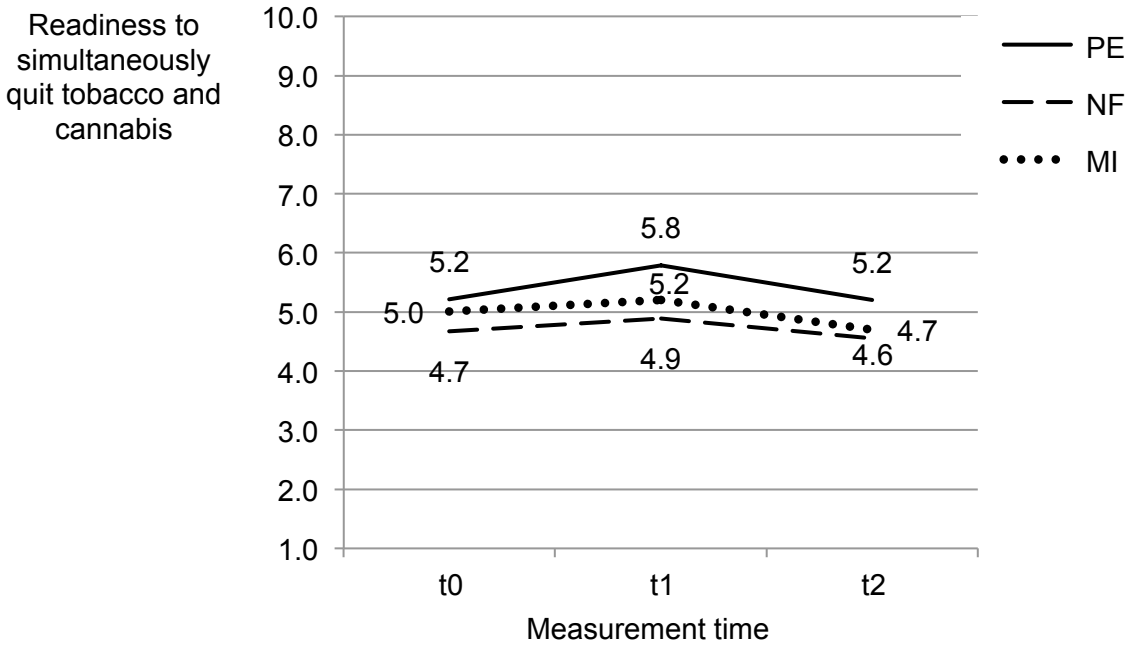

Figure 7. Course of readiness to simultaneously quit tobacco and cannabis use over time. PE = psychoeducation, NF = normative feedback, MI = motivational interviewing, t0 = baseline, t1 = post-intervention, t2 = 8-week follow-up.

Table 13 displays the results of the GEE models, testing the two hypotheses concerning the differential change in readiness to quit tobacco and cannabis use simultaneously. Regarding H2, there was a significant main effect for time in examining the change in readiness to quit simultaneously from baseline (t0) to the post-intervention (t1) assessment. However, this effect was not maintained at follow-up (t2). Furthermore, neither the intervention effect nor the time*intervention interaction was significant. As the analysis of H3 revealed, there were no significant time effects for readiness to quit simultaneously when only MI and NF were included in the model. In both models, the control variable baseline readiness to stop cannabis use at baseline was a significant predictor of readiness to stop both tobacco and cannabis use simultaneously.

The complete case analyses replicated these findings. The first model using the total sample revealed a significant time effect at t1, $B = 0.31$, $SE = 0.11$, 95% CI [0.37, 1.54], $p = .001$, but not at t2 ($p = .17$). Regarding H2, only the time effect observed when comparing

the post-intervention with the baseline assessment was significant, $B = 0.95$, $SE = 0.18$, 95% CI [0.37, 1.54], $p = .001$). In the model used to test H3, there was no significant effect, except the control variable baseline readiness to quit cannabis use.

Table 13. *Results from linear generalised estimating equation (GEE) models examining readiness to quit tobacco and cannabis use simultaneously according to Hypotheses H2 and H3*

Hypothesis	**Parameter**	***Coefficient B***	***SE***	**95% *CI***		***p***
				lower	upper	
H2	Intercept	1.83	0.38	1.07	2.58	<.001
	Groups NF & MI [a]	0.07	0.25	-0.43	0.56	.80
	Time t2 [b]	-0.06	0.42	-0.89	0.78	.90
	Time t1 [b]	0.59	0.19	0.22	0.96	.002
	Time t2 [b] × Groups NF & MI [a]	-0.12	0.40	-0.90	0.66	.76
	Time t1 [b] × Groups NF & MI [a]	-0.40	0.22	-0.83	0.03	.07
	Baseline readiness to stop cannabis use	0.57	0.04	0.48	0.65	<.001
	Female gender [c]	0.17	0.29	-0.40	0.74	.56
H3	Intercept	1.59	0.45	0.70	2.47	<.001
	Group MI [d]	0.20	0.29	-0.37	0.76	.50
	Time 2 [b]	-0.03	0.42	-0.88	0.81	.94
	Time 1 [b]	0.22	0.14	-0.06	0.50	.13
	Time 2 [b] × Group MI [d]	-0.30	0.45	-1.18	0.58	.50
	Time 1 [b] × Group MI [d]	-0.06	0.28	-0.60	0.48	.83
	Baseline readiness to stop cannabis use	0.59	0.05	0.49	0.69	<.001
	Female gender [c]	0.29	0.41	-0.50	1.09	0.47

Note. GEE models with 20 imputed data sets. *SE* = standard error; MI = motivational interviewing intervention; NF = normative feedback intervention. [a] reference: PE (psychoeducation); [b] reference: t0 (baseline); [c] reference: male gender; [d] reference: NF.

Effects of the Intervention on Secondary Outcomes

Descriptive statistics for the frequency of tobacco and cannabis use showed only a weak

decrease in frequency between the baseline and follow-up assessments (Table 14). The GEE model that analysed H1 did not reveal a significant time effect for the frequency of either tobacco use, Incidence Risk Ratio *IRR* = -0.04, *SE* = 0.09, 95% *CI* [-0.23, 0.15], *p* = .70, or cannabis use, *IRR* = -0.05, *SE* = 0.12, 95% *CI* [-0.29, 0.20], *p* = .70.

None of the analyses of differential changes in the frequency of either tobacco or cannabis use revealed a significant time effect, intervention effect or time*intervention interaction.

The complete case analyses predominantly replicated these findings, revealing no significant time, group, or time*group interaction effects in the GEE models of tobacco or cannabis use frequency. One exception was a significant time effect for the frequency of tobacco use among the total sample (H1), *IRR* = 0.89, *SE* = 0.04, 95% *CI* [0.81, 0.98], *p* = .02).

Table 14. *Means and standard deviations of the frequency of tobacco and cannabis use at baseline and 8-week follow-up*

Outcome variable		**PE**	**NF**	**MI**	**Total**
		M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Tobacco use frequency	t0	12.5 (2.4)	12.0 (2.5)	13.6 (2.5)	12.7 (2.5)
(cigarettes per day)	t2	12.5 (2.5)	11.0 (2.5)	13.4 (2.7)	12.3 (2.6)
Cannabis use frequency	t0	2.5 (1.4)	2.3 (1.4)	2.3 (1.4)	2.3 (1.4)
(times per week)	t2	2.4 (1.4)	2.2 (1.4)	2.2 (1.4)	2.2 (1.4)

Note. Descriptive statistics were calculated using the 20 imputed data sets. PE=psychoeducation, NF=normative feedback, MI=motivational interviewing, t0=baseline assessment, t2=8-week follow-up assessment.

Discussion

Principal Results

This study evaluated three brief, fully automated web-based interventions which aimed to enhance co-smokers' readiness to simultaneously quit their tobacco and cannabis use.

Regarding one's readiness to simultaneously quit using tobacco and cannabis, we assumed that all participants would have an increased level of readiness after the intervention compared to the baseline assessment (H1). Furthermore, we hypothesised that more interactive and individually tailored interventions would be more effective compared to mere information provision (psychoeducation) (H2). Additionally, we tested the hypothesis that a web-based intervention that applies principles derived from MI would be even more effective than an intervention that provides tailored, normative feedback (H3). The hypotheses regarding these secondary outcomes as well as tobacco and cannabis use frequency were analogous.

Regarding the readiness to simultaneously quit tobacco and cannabis use, the results supported our first hypothesis, That is, in the total sample, the readiness to simultaneously quit was significantly elevated at the post-intervention assessment relative to baseline. This effect had disappeared by the 8-week follow-up assessment. The two hypotheses that assumed differential intervention effects were thus not supported. With regard to the frequency of tobacco and cannabis use, our analyses did not reveal time or intervention effects.

Strengths and Limitations

Among the strengths of this study is that it is the first study of web-based interventions that target co-smokers of tobacco and cannabis. Furthermore, the interventions are fully automated and therefore require no personnel beyond their initial development.

Among the limitations of this study was its high attrition rate regarding participation at the follow-up assessment. However, high attrition rates are common in eHealth studies and brief interventions (Eysenbach, 2005). We addressed this by using multiple imputation methods and performing traditional complete case analyses. Furthermore, our primary focus was set on the post-intervention assessment. Loss to follow-up therefore mainly limits the interpretability of the results regarding our secondary outcomes and the frequency of tobacco

and cannabis use. A further limitation is that we did not include an assessment-only control group and could therefore not control for baseline assessment effects. This again represents a reason that our primary focus was on the post-intervention assessment. In addition, the interventions between baseline and the post-intervention assessment were very brief. Therefore, individuals of an assessment-only control group would have had to be reassessed after less than 30 minutes. Finally, the NF and MI interventions differed in length. While the intervention sessions for MI and PE participants both lasted nearly 30 minutes, the duration of an NF intervention session was approximately 11 minutes shorter. This difference was also reflected in the higher participation rate among NF participants in the post-intervention session. The possibility that we would have achieved significant differences between these two interventions if they would have been equally long can therefore not be excluded.

Comparison with Prior Findings

The comparability to prior studies is limited because no web-based interventions that target the co-use of tobacco and cannabis have been published. Additionally, web-based MI interventions that are delivered fully automated and do not use chat-based MI- counselling are rare. However, the significant time effect in our study and the absence of differential intervention effects on readiness to quit are in line with the findings of a study that compared a single-session of MI-based chat-intervention with a chat in which participants received technical information about the baseline self-test (Jonas et al., 2012). That study included problematic alcohol and cannabis users but targeted only the particular problem behaviour. The interventions were comparable to the MI and PE interventions of the current study with regard to their length but differed from the current interventions because they were not delivered in an automated fashion.

Moreover, we speculate that providing knowledge was a relatively effective measure in our study because co-smokers' baseline knowledge about the relationship between tobacco

and cannabis use seems to be generally modest (Becker et al., 2013). In addition, the psycho-educational intervention was the only intervention that provided information on the risk of physical harm from cannabis use. In one previous study, awareness of this risk was a significant predictor of readiness to simultaneously quit (Becker et al., 2013).

There are several possible explanations for the lack of time effects on the frequency of tobacco and cannabis use. First, the interventions were conceptualised as motivational enhancement interventions and targeted co-smokers who were in lower stages in the process of behaviour change. The interventions therefore mainly contained motivational contents and only very few elements that are commonly applied to support the cessation or reduction of tobacco or cannabis use, such as the development of personal strategies or skills training. It has been previously shown that the effectiveness of internet interventions in creating behaviour change is associated with the incorporation of behaviour change techniques (Webb, Joseph, Yardley, & Michie, 2010). In addition, the studied interventions were very brief compared to web-based treatment interventions, which revealed significant effects on either tobacco use (Haug et al., 2011; Woodruff et al., 2007) or cannabis use (Rooke, Copeland, Norberg, Hine, & McCambridge, 2013; Tossmann, Jonas, Tensil, Lang, & Strüber, 2011). This explanation is supported by the fact that other studies that analysed web-based interventions of a comparable length also revealed no effect on cannabis use (Jonas et al., 2012; C. M. Lee, Neighbors, Kilmer, & Larimer, 2010). It should also be considered that the current interventions targeted two behaviours simultaneously, which may require especially intensive interventions. Finally, the high attrition rate limits the interpretability of our findings concerning behaviour change. This limitation is also illustrated by the different findings from the intent-to-treat and the complete case analysis.

Moreover, the appropriateness of fully automated MI is questionable because central components of the MI approach, such as therapeutic rapport, cannot be realised in an online setting. The efficacy of fully automated MI might be particularly limited when two

behaviours are targeted simultaneously, as this presumably provokes much ambivalence that cannot be counterbalanced by a therapist. However, in brief face-to-face interventions for universal drug prevention and early intervention, MI was also not more effective than advice (McCambridge et al., 2011, 2008). Compared to our study, however, significant changes over time in tobacco, cannabis, and alcohol use were achieved in both intervention groups. Furthermore, a web-based intervention to promote smoking cessation using seven 45-minute sessions with MI-based video-chat in a virtual reality world revealed both significant time and intervention effects but used an assessment-only control condition (Woodruff et al., 2007).

Conclusions

The findings of this study suggest that brief, fully automated web-based interventions have a short-term but perhaps no longer-term effect on co-smokers' readiness to simultaneously quit tobacco and cannabis use. There were no differential intervention effects, indicating that psychoeducation is no less effective than are more individualised, interactive interventions when the co-use of tobacco and cannabis is targeted. Moreover, neither time nor intervention effects on substance use behaviour were found. For dual-health behaviour change, more intensive interventions regarding the length and the mode of administration (fully automated vs. face-to-face, text-chat or video-chat) may be needed. Future studies could examine more comprehensive web-based treatment interventions for co-smokers and examine the efficacy of chat-based MI-counselling in this target group.

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Publications

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Becker, J., Hungerbuehler, I., Berg, O., Szamrovicz, M., Haubensack, A., Kormann, A. & Schaub, M. P. Development of an integrative cessation program for co-smokers of cigarettes and cannabis: demand analysis, program description, and acceptability. *Substance Abuse Treatment, Prevention, and Policy, 8:*33. DOI:10.1186/1747-597X-8-33

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